# The Conduct of Monetary Policy under Risks to Financial Stability: A Game – Theoretic Approach

by

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**Abstract**

Asset prices offer useful information for monetary policymakers in the short-term, yet their significant relationship to primary policy-indicators is debated. In one view bubbles are difficult to recognise and central banks should act just against the adverse consequences of their unwinding. The opposite view advocates 'pre-emptive' monetary policy as financial imbalances accumulate aiming to forestall such consequences. After reviewing the debate, we evaluate 'pre-emptive' monetary policy when financial stability is an explicit objective replacing the output-gap. Modelling a game between a central bank and the financial sector similar to Barro and Gordon (1983), we examine monetary policy under commitment and discretion. In contrast to the relevant literature, we conclude that pre-emptive monetary policy succeeds in better controlling inflation, anchoring inflation expectations and imposing more discipline to the financial sector when committed to a rule. The model is extended to incorporate incomplete information about the policy objectives. We evaluate the effect of vagueness about the central bank's preferences for financial stability in the behaviour of the central bank and the financial sector, and how reputation-building affects the conduct of discretionary policy. Finally, we discuss the relevance of our conclusions in the light of the global financial crisis initiated in August 2007.

# CHAPTER 1

# INTRODUCTION

The period since the early 1980s has been decisive for the evolution of monetary theory and practice. As far as the practice is concerned, the crucial factor has been the very success of several central banks to actually acquire and maintain credibility for low inflation, and improve for several years the stability of inflation and output relative to potential. Indeed, it is accepted that central banks can and should primarily use monetary policy in order to maintain low inflation over time. Such commitment to price stability renders monetary policy more successful in stabilizing employment over the business cycle. Moreover, greater transparency is also accepted to enhance the effectiveness of monetary policy. With respect to the theory, the decisive improvement has been the introduction and wide acceptance of rational expectations in models of monetary policy, as it mainly enabled the incorporation of forward-looking elements of aggregate demand and price-setting in the latter, which also enabled the understanding of the success of monetary policy in practice.

However, different views have been expressed about the various specific channels through which monetary policy actions are transmitted to the real economy (in particular, into changes in real GDP and inflation), which are complicated and still imperfectly understood. Therefore, a relatively clear knowledge of this transmission process is vital for the appropriate conduct of monetary policy.

*Chapter* 2 begins with a broad overview of the main channels of the transmission of monetary policy proposed in the extant literature, followed by a discussion of the factors that may alter these transmission channels or affect their relative importance. Furthermore the analysis is followed by a concise, penetrating, analytical presentation identifying the channels of monetary transmission mechanism.

Monetary policy can have an impact on asset prices and exchange rates because of the effect it has on financing conditions in the economy, especially due to its impact on expectations. Interest-rate and financial asset-price changes influence saving, spending and investment decisions of households and firms. A fall in asset prices tends to cause strong effects on spending when the consequent change in debt-to-asset ratios hampers debt repayment for households and firms. Similar effects can arise when general sentiment deteriorates about the ability to service debts in the future. It has been argued, however, that certain direct effects of monetary policy on aggregate spending are not captured by the transmission via the traditional interest-rate or exchange-rate channels, and they, consequently, focus mainly on the critical role credit markets have in the transmission of monetary policy actions.

As emphasized in most of the surveys cited in *Chapter* 2 (according to the so-called lending view), monetary policy actions create two effects, namely one that focuses on bank loans and another on borrower balance-sheets. In both, capital market imperfections that enable certain firms to obtain financing instead of others actually determine the effectiveness of monetary policy. Since changes in credit conditions are not reflected only in interest-rate levels, it is important to understand the ways in which credit-market imperfections determine the macroeconomic equilibrium, as well as the channels of the transmission of monetary policy decisions to the real economy.

*Chapter* 3 gives a review of the nature and origins of the key elements of the current consensus, i.e. the considerable convergence in theory and practice of monetary policy in the last thirty years. The latter includes an account of the components of the consensus theory of monetary policy, reflecting the emergence of the explicit interest rate policy. Then follows a concise presentation of the prevailing model of monetary policy that constitutes the main workhorse model most central banks use as a guide to monetary policymaking.

The stability of the financial system promotes the smooth functioning of the payment systems and the effective transmission of monetary policy, thus, ensuring that the primary monetary policy objective of achieving and maintaining price stability is reached. Furthermore, a robust financial system enhances the resilience of the economy to shocks of various sources, having also an effect on the overall performance of the economy.

It is necessary to discuss to what extent risk can be shouldered by a central bank while ensuring its asset soundness, although a specific evaluation of risks attached to individual assets goes beyond the scope of this thesis. It has been pointed out, however, that when the public sector and a central bank shoulder private-sector credits in an extremely large amount, as it may be the case in facing the current serious financial crisis, such behaviour might be at quite a substantial social cost that would erode the mechanism of capitalism (Oda and Okina (2001), p. 334).

Thus, *Chapter* 4 explores the relationship between financial stability, deflation, and monetary policy. The discussion starts by reviewing major issues concerning financial stability/instability, then addressing financial stability and price stability and continues to analyse monetary policy, asset prices and the consequences of financial distress for asset price fluctuations and banking crises.

Bubbles in asset prices create distortions to nearly all economic decisions. Wealth effects create rapid expansions in consumption followed by vast collapses. Increases in equity prices enable firms to finance new projects, causing a boom in investment, followed by a bust. In addition, fiscal revenue rises in a booming economy, and encourages, thus, cuts in taxation and increases in expenditure. After the consequent, inevitable, slump in asset prices such fiscal policy actions are politically difficult to reverse. Therefore asset price bubbles can create volatility in consumption, investment, financial intermediaries' solvency, and fiscal policy.

Furthermore, the flow of information may be disrupted, and price discovery may be impaired during periods of financial distress. The increased uncertainty that characterizes the disruption in the information flows results in high risk spreads and a reluctance to purchase assets. It is, therefore, of particular importance for understanding financial instability to investigate the entailing risks.

In addition, shocks interfering with the flow of information in various parts of the financial system span from higher interest rates to problems in the banking sector, and increases in uncertainty to asset-market effects on balance-sheets. The recent economic turmoil gives credence especially to the last two. Financial instability, in the absence of any remedial action, can produce a severely adverse impact not only for the functioning of financial markets but also for the overall prospects of a country's economy.

To sum up monetary policy authorities face the central concern of finding and evaluating ways to prevent financial instability. In this endeavour one needs, first, to understand the nature of financial instability and the effect it may impose to the macroeconomy. In particular, severe boom-and-bust cycles can lead to severe destabilisation in both inflation and output in an economy. Consumption is affected as well as investment, fiscal policy, and the health of financial intermediaries. Most importantly, the down-side risks that they pose are significant. Since central bankers undertake a form of risk-management of the economic and financial system, they are bound to address these risks. This is the purpose of *Chapter* 5, namely to search the extant literature and to provide a coherent way for understanding all these intricate issues that did not appear to be so widely and obviously alarming, or even dramatic, five years ago when I first started to undertake PhD research dealing intensively with this subject.

In connection to this chapter (*Chapter* 5) the following *Chapter* 6 concentrates on whether and how monetary policy should respond to asset price bubbles. The appropriate response, if it is considered appropriate to give any response at all, has been a matter of extensive debate during the last fifteen years (initiating roughly during 1994-2000 with the U.S. stock market boom and expanding with the subsequent recession). It is vital, however, to make the distinction that both academics and central banking practitioners agree that in the aftermath of a bursting of a bubble monetary policy needs to be conducted in a way that counters the adverse consequences brought forward. Therefore, we do not address the important issue of how monetary policy can enhance the recovery of an economy that has already fallen into a post-financial-crisis recession, that is currently of major concern to both academics and policymakers in view of the current global financial and economic turmoil.

As financial crises and economic contractions tended historically to follow periods of explosive asset-price growth, it is argued that monetary policy can restrain the adverse effects that financial instability may impose on the economy overall, just by attempting to defuse asset-price booms at a relatively early stage. However, how likely it is that asset prices eventually collapse leading also to a macroeconomic decline may depend on the underlying reason of their appreciation.

According to the traditional view a reaction of monetary policy to asset-price misalignments is justified only when asset prices are known to provide useful information about the future course of inflation. In particular, so long as monetary policy maintains price stability, it promotes financial stability as well. This view holds that financial crises (or simply "financial imbalances") need to be tackled by lender-of-last-resort practices or regulatory policies. Of course, any attempt to evaluate the appropriate monetary policy response to asset price bubbles should not fail to consider primarily the explicit objectives of monetary policy, and its ultimate aim to promote public welfare by fostering economic prosperity.

However, the traditional view has been (at least partially) criticised by several economists. Since asset price movements lead to macroeconomic fluctuations affecting prices and employment, the monetary authorities are bound to be concerned with the former. Yet, several crucial issues need to be addressed before a monetary policy response. *Chapter* 6 analyses in a critical way such questions as whether monetary policy should react directly to asset prices or, even, if asset prices need to appear in some form in a reaction function a central bank uses as a guide for monetary policy.

Furthermore, when policymakers face large fluctuations in asset prices but muted inflation expectations, it is considered whether inflation is measured accurately, as well as whether price stability is ensured. It is debated whether asset prices should be taken into account when defining price stability, and, generally, whether asset prices may play a significant role in the conduct of monetary policy. Additionally, even though it is widely accepted that asset prices offer (even partially) useful information to monetary policymakers in the short-term, views are mixed about whether they bear any strong link to the primary indicators of monetary policy (output gaps and inflation forecasts).

The debate pins down to whether price stability is sufficient to foster overall financial stability, or whether a trade-off exists (at least in the medium-run). If the latter is the case, it is questioned whether monetary policy should exercise its influence in order to counter asset price bubbles when they grow (before forecasts to inflation are affected) or respond to their effects after they unwind. The conventional view accepts that asset price misalignments are difficult to recognise and that central banks should act just against the adverse consequences of a bubble unwinding. The opposite view advocates the merits of the so-called ‘pre-emptive’ monetary policy conducted as financial imbalances accumulate with the aim to forestall the potential adverse consequences in the aftermath of a crisis, especially since low and stable inflation is thought to possibly mask threats to the economy that weaken the financial system and which cannot be captured by an output gap measure.

In line with the above debate, in *Chapter* 7 we address the second view as a policy option and evaluate pre-emptive monetary policy when a central bank considers financial stability as an explicit policy objective, yet replacing the output gap. Accepting that the effect of the policy instrument is transmitted through the financial sector, a central bank recognises that respective reactions from the latter can either enhance or hamper the implementation of monetary policy to the real economy. To capture that aspect – (to our knowledge) in contrast to the extant literature – we construct a simple model of the strategic interaction between a central bank and the financial sector in a closed economy in line with the tradition that started with the seminal work of Barro and Gordon (1983a). We examine monetary policy both under commitment to an instrument rule and under discretion, motivated, principally, by the concluding remarks in Bordo and Jeanne (2002) that “financial stability presents a direct challenge to the rule paradigm because it may require occasional deviations from simple rules – i.e. policies that are sometimes based in a complex way on discretionary judgment”. To our knowledge, the literature in favour of pre-emptive monetary policy against financial instability (as presented in *Chapter* 6) puts forward the conclusion that the monetary authorities should exercise their policy with more flexibility and over longer policy horizons. On the contrary, our analysis concludes that when a central bank addresses financial stability as a main and systematic component of its decision making process, namely as an explicit monetary policy objective, then monetary policy yields better results in terms of controlling inflation, anchoring inflation expectations and imposing more prudence to the operation of the financial sector when conducted under commitment to a rule. Therefore, we contend that the contribution is twofold. Namely, in terms of the method used and in terms of the results proposed.

Furthermore, the analysis in *Chapter* 8 aims to evaluate the effect of vagueness about the central bank's preferences with respect to financial stability both in the behaviour of the central bank and the financial sector. The model in *Chapter* 7 is extended to incorporate incomplete information received by the financial sector concerning the objectives the central bank aims at; the two possible cases addressed are a central bank that may aim solely on price stability and a central bank that may be of the type analysed in the model of the previous chapter. In this context it is investigated whether central banks should state clearly their intention to conduct monetary policy pre-emptively against perceived financial imbalances, or in contrast exercise 'strict inflation targeting'. This kind of extension is justified by the fact that central banks have in general been reluctant to publicize any explicit objective function used as a guide for policy, and also because even though central banks have serious concerns about the stability of the financial system, they fail (as of present – to our knowledge) to adopt and aim at financial stability as an explicit monetary policy objective.

In this model since the financial sector is partially informed about the way the central bank conducts monetary policy, even a central bank that prefers to pre-empt financial instability may choose in equilibrium, for suitable levels of parameters, to mimic a 'strict inflation targeting' central bank. The aim is to build its reputation as such in stead of behaving in a way that would reveal its identity by choosing the strategy that maximises its objective function. In this way, it manages to better control inflation expectations, and have a firmer guarantee of the stability of the financial sector. It is finally proven that only for considerably large shocks to inflation, is the 'pre-emptive' central bank willing to reveal its identity and exercise more muted control to inflation in order to reinforce the safety of the financial sector.

The thesis is organised in nine *Chapter*s clustered in three Parts as follows: *Chapter* 1 is the introduction. Then follows ***Part I***, which presents an overview of the state of monetary policy and consists of two chapters, *Chapter* 2 and *Chapter* 3. Then ***Part II*** analyses and reviews critically the central banks' assessment and reaction to asset price bubbles. It includes three chapters, *Chapter* 4, 5 and 6, and represents an extensive analytical review of the relevant literature. Then having built on the experience of exploring analytically the vast theoretical and empirical literature on Part I and Part II, in ***Part III*** , which includes *Chapter* 7 and *Chapter* 8, we present a game-theoretic model of monetary policy under risks to financial stability. In this part, *Chapter* 7 develops a simple model of the strategic interaction between a central bank and a financial sector in a closed economy in order to analyse the conduct of monetary policy pre-emptively against financial instability and *Chapter* 8 extends the previous model to incorporate uncertainty referring to whether the conduct of monetary policy is pre-emptive against financial instability or not. Finally, *Chapter* 9 reports the main conclusions of the thesis as they have been analytically received in the previous chapters and discusses the relevance of our conclusions in the light of the current global financial crisis initiated in August 2007.

# PART ONE

## THE STATE OF MONETARY POLICY: AN OVERVIEW

# CHAPTER 2

# THE TRANSMISSION MECHANISM OF MONETARY POLICY

## 2.1 Introduction

The design of monetary policy and the achievement of the mandated and implicit objectives of a central bank are, in essence, determined by the transmission process of the chosen monetary impulses to the economy under consideration; in the case of the design of monetary policy, in forecast terms and in the case of the implementation in actual time. Even deciphering the past is vital for the monetary authorities, as the majority of empirical work is undertaken by using methods based in variants of time series analysis. The vast amount, intensity, and uniqueness with respect to time and entity of the choices taken by economic agents, in addition to the strategic interaction between the latter, are some of the factors that increase the complexity of the context that monetary policy is penetrating in order to have a desired effect on the economy. This chapter begins with an overview of the monetary transmission mechanism followed by a discussion of the main channels of the transmission of monetary policy proposed in the extant literature.

## 2.2 The Monetary Transmission Mechanism

Economists have not reached a consensus about the ways in which monetary policy affects the economy. Several specific channels through which monetary policy works have been proposed and different observers apply different weights of importance on each of those channels. In fact, views diverge even about the monetary transmission process. However, it is vital to the design and implementation of monetary policy that the policy authorities have a clear (even to a certain degree) grasp of the transmission process. Furthermore, central banks need to be alert to the impact of structural change, and in particular need to execute the strenuous task of continuously reinterpreting the channels of transmission of monetary policy. This is necessitated by the fact that changes in the structure of the economy, such as changes in financial sector technology and institutions, in balance-sheet positions, or in expectations concerning future policy, alter the economic effects of a given monetary policy measure (Kamin, Turner and Van't dack (1998), p. 5).

After accepting the effect of structural change, we need to point out, however, that monetary policy transmission is seldom analysed as regime contingent and that as Leijonhufvud (2001) stresses most of the literature reads as if in pursuit of a 'general' theory. Yet the prevailing view among monetary economists of how transmission works and the degree of effectiveness of monetary policy has changed repeatedly over time (for a comparative account see Leijonhufvud (2001)). He further concludes that, in retrospect, it seems obvious that these permutations of transmission theory have been largely driven – with some time-lag – by successive regime changes in the economic system under study (see Leijonhufvud (1990), and Leijonhufvud (2001) p. 15).

Nevertheless, during the last decade, the practice of inflation targeting has gained broad acceptance among central banking practitioners and academics, emphasising in essence price stability as the sole objective of monetary policy and eschewing consideration of other goals, as for example growth or employment. Such consent does not emphasise price stability as more important a goal than growth or employment. The rationale behind it is that an activist monetary policy, undertaken in order to offset a cyclical downturn, rather than the pursuit of medium-term price stability, will over time give rise to the reverse effects. In addition, the desire to focus on a single objective for monetary policy is based on the fact that both economists and policy-makers consent that the long-term growth of the economy cannot be affected by monetary policy.

Efforts to stimulate growth above its potential rate merely lead to higher inflation and, consequently, monetary policy can at most only moderate short-run fluctuations in output [1]. Doubt is even cast on whether discretionary monetary policy can effectively moderate economic fluctuations. A stream of issues makes it difficult to time policy actions accurately enough to accomplish such moderation. These include the very agreement on the existence of business cycles, the prompt timing in the

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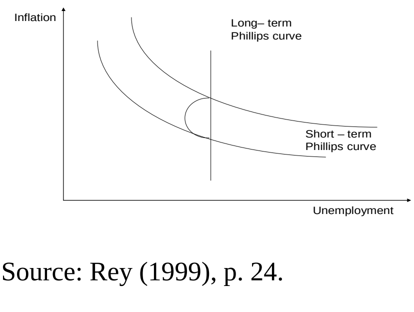
[1] In the short term, there is a positive correlation between unexpected inflation and growth. An inflationary monetary shock can stimulate activity only when its inflationary impact is unexpected. In this case, the authorities need to convince the public that their policy is non- inflationary, while it actually is. This effect though cannot last long and, as illustrated in Graph 2.1, the Phillips curve itself moves to higher levels of inflation for a given rate of growth. In the longer-term, activity cannot be affected through channels of competitiveness or confidence. Nevertheless, monetary policy can actually have a positive impact on activity when the policy stimulus is seen to be fully consistent with price stability.

***Graph 2.1***




Source: Rey (1999), p. 24.

effective recognition of the turns in a cycle, in addition to subsequent lags in the response of the economy to changes in monetary policy. Moreover, as is pointed for example by Kamin et al. (1998), while many central banks may in practice continue to attempt to stabilise output, they abstain from such statement in their public mandate and yet restrict the latter to price stability alone, since this renders them less vulnerable to any political pressure for expansionary policy (Kamin, S., P. Turner and J. Van't dack (1998), p. 6).

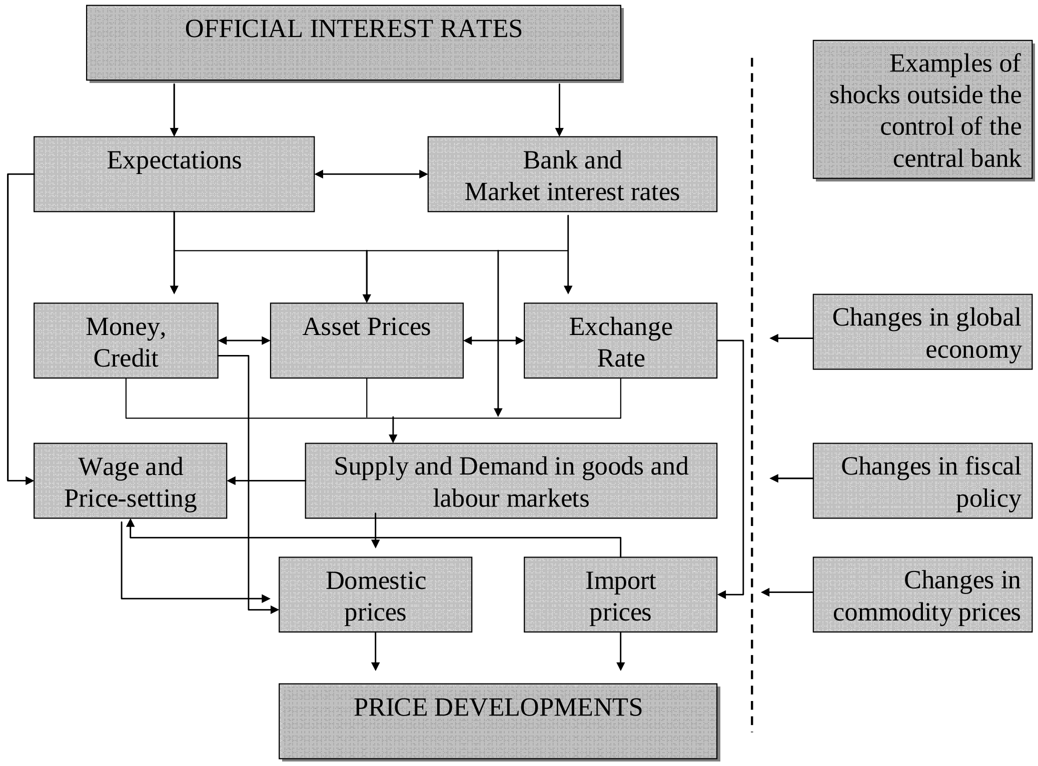
## 2.3 A Concise Account of the Channels of Monetary Transmission

This section starts with the illustration of the main channels of monetary policy transmission in a simplified form, as in Chart 2.1[2], followed by a brief explanation. The following section (2.4) gives a more thorough presentation and analysis of the main four channels as classified by the relevant literature on the theories of the monetary transmission mechanism.

The transmission mechanism of monetary policy can be defined as "the process through which monetary policy decisions affect the economy in general, and the price level in particular. The individual links through which monetary policy impulses (typically) proceed are known as transmission channels" (ECB (2004), p. 44).

[2] A detailed comprehensive analysis is provided, for example, by Sinclair (2005a) (especially pp. 16-21), where he examines how and why policy rates changes take place and discusses key initial aspects of the transmission mechanism for policy rates, such as their impact on other interest rates, other asset prices, and the major components of aggregate demand, consumption and investment (Sinclair (2005a), p. 39). In addition, Sinclair (2005b) examines the next stages of the transmission mechanism on how a change in the level of aggregate demand translates into changes in output and prices and labour markets.

***Chart 2.1: A stylised illustration of the transmission mechanism from interest rates to prices***




Source: ECB (2004), p. 45.

The transmission mechanism is actually a long chain of cause and effect that links monetary policy decisions with the price level and starts with a change in the level of the official interest rates[3] set by the central bank on its own operations[4]. Since the

[3] An examination of what prompts changes in official interest rates, important though it is, is not accounted for as it lies beyond the scope of this chapter. Sinclair (2005a) identifies four main influences. Namely, that there are "current levels or forecasts, of inflation; current levels or forecasts of the output gap (i.e. the difference between the economy's level of real income, and its estimated potential); the market's expectations of future policy rates (if available); and official interest rates abroad" (Sinclair (2005a), p. ). Then Sinclair (2005a) analyses all four influences and provides econometric evidence for the messages given by interest rate data for a large sample of 37 countries.

[4] These operations typically account for the central bank's providing funds to the banking system (see for example ECB (2004) Chapter 4, for a detailed account of the instruments of monetary policy in the Eurosystem). The banking system demands money issued by the central bank in order to meet the demand for currency from the public, meet the reserve requirements of the central bank, and clear interbank balances.

central bank has a monopoly over the creation of base money, it can fully determine the interest rates on its operations. As it affects in this way the funding cost of liquidity for banks, banks are inclined to pass on these costs when lending to their customers (ECB (2004), p. 44).

The central bank can, thus, steer money market interest rates by exerting, through this process, a dominant influence on money market conditions. Changes in money market rates in turn affect other interest rates, yet to varying degrees. They have, for example, an impact on the interest rates on short-term loans and deposits that are set by banks. Furthermore, expectations of future policy rate changes have an effect on longer-term market interest rates, since the latter reflect expectations of the future evolution of short-term interest rates. Yet, the impact of money market rate changes on interest rates at very long maturities (as for example long-term bank lending rates, 10-year government bond yields) is not direct enough to be estimated. Those rates depend to a large extent on market expectations for long-term growth and inflation trends in the economy. Therefore, only if the changes in the official rates are to lead to a change in market expectations concerning long-term economic trends, can they affect the longer-term rates (ECB (2004), p. 45).

However, the conventional model of the monetary transmission views a shift in policy as steering a change in the money supply that, for a given money demand, results in a change in money-market interest rates. The changes in the official and interbank rates lead, in turn, to changes in bank loan rates for borrowers and in deposit rates. The former tend to affect investment decisions and the latter the choice of consumption between the present and the future.

A principal issue in this channel of transmission is the extent to which a policy-induced change in the official rate affects all short-term money market interest rates, and spreads, in turn, to the entire spectrum of interest rates, having an effect in particular to the long-term interest rates that are most relevant to investment (including housing) or to purchases of durable goods. In fact, several factors affect the propagation of monetary policy actions along the term structure, including the organisation of financial markets and the state of expectations.

As Kamin et al. (1998) point out, since the present value of durable goods is inversely related to the real interest rate, a lower rate of interest increases the present value of such goods and thus increases demand. They further note that, “in this framework, changes in the marginal cost of borrowing affect interest-rate-sensitive spending. Changes in interest rates also lead to changes in average rates on outstanding contracts, and these changes increase over time as old contracts come up for renegotiation. Similarly, marginal adjustments in deposit rates will over time change the average deposit rate. These changes in average interest rates will affect the income and cash flow of borrowers and lenders. Policy-induced movements in average interest rates could thus lead to cash-flow-induced changes in spending (akin to income effects) that could be as important as – or more so than – the substitution effects associated with changes in marginal interest rates. In particular, balance-sheet positions would determine the relative importance of marginal versus average interest rate effects” (Kamin, Turner and Van’t dack (1998), p. 10).

For a distinction between the effects of marginal and average interest rates, it is important to distinguish between real and nominal rates. Kamin et al. (1998) further define that “the real interest rate affects the marginal cost of borrowing that determines spending and saving decisions. While a rise in nominal interest rates that reflects higher inflation expectations – so that the real rate remains constant – will not change the perceived marginal cost of borrowing, it will alter the cash-flow and balance-sheet positions of borrowers as it changes the average rate of interest. It does this because the portion of interest payments associated with the inflation premium represents a prepayment of the real part of the debt, so that changes in inflation alter the effective maturity of loans” (Kamin, Turner and Van’t dack (1998), p. 10). Such cash-flow effects may affect aggregate demand to a great extent.

Monetary policy can have an impact on other financial variables such as asset prices and exchange rates because of the effect it has on financing conditions in the economy, especially due to its impact on expectations. In economies where long-term fixed interest bond markets are important, higher short-term interest rates may lead to a decline in bond prices. This channel of transmission may, in fact, be strengthened as such markets develop. Interest-rate and financial asset-price changes influence saving, spending and investment decisions of households and firms[5]. Furthermore, changes in official interest rates may also affect the supply of credit[6]. Furthermore, movements in asset prices may affect consumption and investment via

[5] For example, ceteris paribus, higher interest rates make it less attractive for households or firms to borrow in order to finance their consumption or investment. In addition, in this case it is more attractive for households to save their current income instead of spending it, since the return on their savings is increased (ECB (2004), p. 45).

[6] For example, after an increase in interest rates, a number of households or companies that are willing to borrow will face a higher risk of not safely repaying their loans such that banks will not grant them a loan. Consequently, such borrowers would be forced to postpone their consumption or investment plans (ECB (2004), p. 45).

income and wealth effects[7]. Asset prices can also affect aggregate demand via the value of collateral that allows borrowers to get more loans and/or to reduce the risk premia demanded by lenders or banks. The amount of collateral tends to influence lending decisions as when its value falls, loans will become more expensive and even difficult to obtain at all, with a resulting decrease in spending (ECB (2004), p. 45-46).

Another theory that explains the way asset price changes induced by monetary policy can affect aggregate demand is the so-called *q* theory of investment proposed by Tobin[8].

As *q* is the ratio of the market value of a firm to the replacement cost of its physical assets, with an easier monetary policy stance, equity prices may rise, increasing thus the market price of firms relative to the replacement cost of their capital. This will lower the effective cost of capital, since newly issued equity can come at a higher price in comparison to the cost of real plant and equipment. Therefore, even though loan rates charged by banks react little, or with a longer lag, to the policy easing, monetary policy can still affect the cost of capital and, thus, investment spending. Asset-price changes induced by policy may also have an effect on the net worth of households and enterprises and, hence alter demand. Such changes will tend to trigger a revision in income expectations and make households adjust their consumption. Similarly, policy-induced changes in the value of assets that are held

[7] For example, households owning shares, as equity prices rise, become wealthier and may choose to increase their consumption, or the opposite might hold when equity prices fall (ECB (2004), p. 46).

[8] See Mishkin (1995) pp. 6-7 for a concise presentation.

by firms will alter the amount of resources available to finance investment (Kamin, Turner, and Van't dack (1998), p. 11).

A fall in asset prices tends to cause strong effects on spending when the consequent change in debt-to-asset ratios hampers debt repayment for households and firms. Similar effects can arise if fears arise about the ability to service debts in the future. If, for instance, stock and bond prices decline, the value of liquid assets available to repay loans will be reduced. Since households and firms become, thus, more vulnerable to financial distress, they may attempt to rebuild their balance-sheet positions by decreasing spending and borrowing.

As is stressed by Kamin et al. (1998), "the effects of monetary policy actions on aggregate demand, working through asset prices and balance sheets, may become amplified as the pace of economic activity begins to respond". They contend that, for example, increases in interest rates that lower asset prices and weaken balance-sheet positions may lead to an initial decline in output and income. This initial decline in economic activity leads to a reduction in the cash flow of households and companies, further increasing their vulnerability to financial distress, and leading to an even further decrease in expenditure. Changes in the monetary stance may, in this way, lead to prolonged volatility in economic activity, even if the initial monetary policy action is promptly reversed (Kamin, Turner and Van't dack (1998), p. 11). In fact, changes in consumption and investment altering the level of domestic aggregate demand for goods and services relative to domestic supply, with a resulting upward pressure on prices, may eventually translate into tighter or looser conditions in labour and intermediate product markets, and these, in turn, can affect wage and price-setting in the respective market (ECB (2004), p. 46).

Turning the focus on the changes in the exchange rate, they normally affect inflation in three ways. First, movements in the exchange rate may have a direct impact on the domestic price of imported goods. If the exchange rate appreciates, the price of imported goods may fall, hence reducing inflation directly, insofar as these products are directly used in consumption. Second, if the imported goods are used as production inputs, lower prices for inputs might, over time, translate to lower prices for the final goods. Third, exchange rate effects tend also to feed to inflation through their impact on the competitiveness of the domestic goods on international markets. If an appreciation in the exchange rate makes domestically produced goods less competitive in terms of their price on world markets, this tends to constrain external demand and thus reduce overall demand pressure in the economy. An appreciation of the exchange rate, ceteris paribus, may therefore reduce inflationary pressures. The strength of the exchange rate effects depends on the relative openness of the economy to international trade. Exchange rate developments tend to be in general less important for a large, relatively closed currency area than for a small open economy (ECB (2004), p. 46).

Financial asset prices depend on several other factors in addition to monetary policy, and changes in the exchange rate are also often determined by these factors. Imperfect information and contract enforcement problems that alter the means by which credit markets clear stand high in terms of importance. For example, when monetary conditions tighten, banks may wish not to rely exclusively on raising interest rates in order to ration available credit, as this would encourage riskier investment behaviour on the part of borrowers, as well as attract riskier borrowers as customers. Responding, thus, to increases in the cost of credit, banks will tend to raise interest rates on loans and also to tighten creditworthiness standards, leading to declines in the supply of credit along with increases in its price. As banks may be unable to distinguish fully between the borrowers whose creditworthiness has been adversely affected and those that has not, even the latter that are still creditworthy will face less favourable terms for their loans during periods of recession and at times of financial distress. Such credit rationing is likely to affect borrowers of smaller funds particularly hard because banks tend to face a higher cost of gathering information about them. Especially where financing sources other than bank lending are scarce or where access to them is limited to a few borrowers, the effects of credit rationing may amplify the conventional interest rate effects of restrictive monetary policy (Kamin, Turner and Van't dack (1998), p. 14).

Furthermore, credit availability may be affected by shifts in loanable resources from one market to another. The view that a "bank lending channel" exists in addition to an "interest rate channel" (which are discussed in greater detail in the next section) mainly lies on the proposition that when monetary policy tightens, banks lose some of the cheaper sources of loanable funds. This rationale would apply particularly to smaller banks which depend primarily on deposits for funding and cannot access other sources of funds (as for example the international capital market) as easily as larger banks. Since certain firms depend heavily or exclusively upon bank financing, shifts in loanable resources from banks to other markets may amplify the effects that higher interest rates alone impose on aggregate demand.

Finally, monetary policy can have a more direct impact on the availability of credit through effects on the value of assets of both borrowers and lenders. Changes in monetary conditions and the resulting changes in asset prices, may affect the value of collateral for bank loans, leading, thus, to changes in the access to credit for borrowers. Moreover, where a large part of bank assets is invested in equities or real estate, any declines in asset prices, lower capital/asset ratios and could force banks to tighten the supply of credit (Kamin, Turner and Van't dack (1998), p. 15).

Monetary policy can influence price developments through other channels that mainly work by influencing the private sector's longer-term expectations. If a central bank has established a high degree of credibility in pursuing its objective, monetary policy can exercise a powerful direct influence on price developments by guiding economic agents' expectations of future inflation and thereby influencing their wage and price-setting behaviour. It is crucial though for a central bank to be credible about maintaining price stability in a lasting manner. It is only when economic agents believe in the central bank's ability and commitment to maintain price stability that inflation expectations remain firmly anchored to price stability. This will consequently affect wage and price-setting in the economy given that, in an environment of price stability, wage and price-setters will not be induced to undertake upward price adjustments for fear of higher inflation. In this respect, credibility facilitates the task of monetary policy (ECB (2004), p. 46 - 47).

## 2.4 Identifying the Channels of the Monetary Transmission Mechanism

A number of surveys of the theories of the monetary transmission mechanism have appeared in the last decade including Bernanke (1993), Gertler and Gilchrist (1993), Kashyap and Stein (1994, 1997), Hubbard (1995) and Cecchetti (1995). Initially, the theories explaining the effect that interest rate changes have on the real economy share admittedly a common starting point. A monetary policy action begins with a change in the level of bank reserves. For this change to have any real effects it is necessary that nominal rigidities are present in the economy. Otherwise, there cannot be an impact on to the real interest rate from a change in the nominal quantity of outside money.

However, the sources of nominal rigidities are considered as relatively unimportant for a discussion of the mechanism by which interest rate changes have short-run effects on output and prices, and so it is deemed as appropriate to move to a discussion of the theories of the transmission mechanism[9]. Seminal work includes Bernanke (1983), Bernanke and Blinder (1992) and Bernanke and Gertler (1989, 1990). These authors distinguish between "the traditional money view", according to which, as in Cecchetti (2001), "interest rate movements affect the level of investment and exchange rates directly, and the 'lending view', in which financial intermediaries

[9] Longer-run considerations, such as the potential costs or benefits of modest levels of inflation, critically depend on understanding the sources of nominal rigidity. Akerlof, Dickens and Perry (1996) and Groshen and Schweitzer (1997) for example, investigate whether small positive levels of aggregate inflation can, in the presence of an aversion to nominal wage declines, facilitate real adjustments, suggesting that the long-run goal for inflation might be positive. Feldstein (1996), however, contends that the tax distortions created by inflation reduce the level of output permanently - an argument suggesting even an optimal level of inflation that is negative. Overall, most economists now seem to agree that inflation leads to lower levels of real output and may even retard long-run growth. Feldstein (1999) gives a summary.

play a prominent role in transmitting monetary impulses to output and prices" (Cecchetti (2001), p. 174).

In essence, monetary policy and its effects can be described as follows. There is a central bank which has the ability to provide a monetary policy impulse: the central bank can, for instance, raise the short-term interest rate or reduce the quantity of central bank money in the economy (and will typically do both at the same time). This impulse has immediate consequences for the interest rate structure and the quantity of money (according to some specific definition of a monetary aggregate) in the economy and for the banking sector. To the extent that banks refinance themselves, or hold voluntary or compulsory reserves, at the central bank, they have fewer funds to offer to their potential borrowers and/or lending becomes more costly to them. The resulting change in the situation of the banking sector has, in turn, consequences for the real economy to the extent that the firms, households and government bodies that want to borrow from the banks have less credit available, or have to pay more for the funds borrowed from the banking sector. The restrictive monetary policy impulse thus works itself through the system and determines aggregate demand and ultimately output and income, and possibly the price level as well (Schmidt (2001), pp. 208-209). Essentially, some details of this process call for further discussion, but evidently it can be assumed that monetary policy is effective, at least in the short run.

### 2.4.1 The classification of channels

As the name suggests, a transmission mechanism is a conceptual or formal model of the ways through which monetary policy influences the real economy. According to Taylor (1995, p. 11) "it is the process through which monetary policy decisions are transmitted into changes in real GDP and inflation". These ways are complicated and, as far as one can judge, still imperfectly understood. In the relevant literature[10], however, four different transmission mechanisms or channels are distinguished:

(a) the interest rate channel

(b) the channel of relative prices

(c) the exchange rate channel, and

(d) the credit channel.

The interest rate channel (a), the exchange rate channel (c) and to a certain extent also the channel of relative prices (b) are standard elements of what may be regarded as the traditional view of the transmission mechanism. The credit channel (d) has been proposed relatively recently and yet enjoys considerable acceptance in the literature.

### 2.4.2 The interest rate channel and the channel of relative prices

The traditional view stated above, which is largely the foundation for the textbook IS-LM analysis, is based on the notion that reductions in the quantity of outside

[10] See for instance the articles by Bernanke and Gertler (1995), Meltzer (1995), Mishkin (1995) and Taylor (1995) in the Journal of Economic Perspectives and the symposium on monetary transmission mechanism, and Goodhart (1989), Cecchetti (1995) for overviews.

money raise real rates of return. This outcome has two effects, one from interest rates to investment and another through exchange rates. An increase in the interest rates renders fewer profitable projects available at higher required rates of return and, thus, reduces investment. A policy action, therefore, causes a movement along a schedule of fixed marginal efficiency of investment. The less close substitutes of outside money for other assets there are in the economy, the more powerful will the interest rate channel be. The exchange rate channel is also widely used in textbook analysis. In this case, an interest rate increase results in a real appreciation of the domestic currency, and in turn reduces the foreign demand for goods produced domestically.

The interest rate channel and the exchange rate channel as models of the monetary transmission mechanism give no explicit role for banks. Both, in fact, are simple two-asset models, refraining from distinguishing between the other assets in the investors’ portfolios.

According to Cecchetti (2001) an important implication of the above ‘traditional model’ concerns the incidence of the investment decline. He asserts that with a lack of externalities or market imperfections, only the least socially productive projects (namely those with the lowest rates of return) will remain unfunded in the economy. Consequently, even though the capital stock is marginally lower, and given that a decline is going to occur, the allocation of the decline across sectors is socially efficient (Cecchetti (2001), p. 175).

More specifically, the interest rate channel is actually based on the conventional Keynesian IS-LM model. According to this model, the central bank determines short-term interest rates. With given and unchanged expectations about the inflation rate, this also has an effect on real longer-term interest rates, which determine the investment decisions of profit maximising firms, as the firms compare marginal internal rates of return on their investment projects with ‘the cost of capital’ when they decide whether to invest or not. Similar considerations apply to certain consumption decisions[11], so that an unexpected change in that interest rate which the central bank can set influences aggregate demand and ultimately also output. Given that prices are inflexible only in the short run – not only by definition, but also in reality – an expansionary or restrictive monetary policy impulse provided by the central bank loses its effect on the real economy over the course of time when prices start to react.

*(a) In order for the interest rate channel to function*, two conditions must be met: for one thing, monetary policy must not only affect short-term interest rates but also (real) medium to long-term rates, and, for another, investment decisions must be interest-elastic. Differences between financial sectors and, more generally, financial systems can translate into differences in terms of the strength of the links between nominal short-term and real long-term interest rates and in terms of the strength of the links between these rates and investment and consumption decisions. The effects of monetary policy are stronger if financial contracts and, in particular, the terms over which interest rates are contractually fixed are shorter and thus more easily adjusted. Another factor which may influence the effectiveness of monetary policy, as its working is described in the interest rate channel view, is the extent to which central bank money is being used in the economy (Schmidt (2001), p. 211).

[11] This is so especially to households’ decisions concerning the acquisition of homes and of consumer durables.

Taylor (1995), for example, discusses that under rational expectations and nominal rigidity, a reduction in the short-term interest rates leads to a decline in the real interest rates at least in the short term, reducing the cost of capital, and, in turn, encouraging a rise in output.

Following Shiller (1979) and Shiller, Campbell, and Schoenholtz (1983), equation (2.1) describes a process where factors such as the central bank's targeting short-term interest rates and announcement with respect to policy stance determine long-term interest rates by affecting the formation of market expectations[12]. The formation mechanism of nominal long-term interest rates treats expected inflation rate as given[13].

$$R_t = \sum_{i=0}^{n} w_i E_t \left( r_{t+i} \right) + \lambda_t . \tag{2.1}$$

$R_t$: long-term interest rates at time $t$ (yield on risk-free long-term government bonds)

$r_t$: short-term interest rate at time $t$ (yield on risk-free short-term government bonds)

$\lambda_t$: risk premium

$w_i$: weight (constant regardless of interest rates)

According to the above equation long-term interest rates are determined by the weighted average of future expected short-term interest rates and a risk premium, which implies that there is an "arbitrage" transaction accompanying risk premium

[12] See Clouse *et. al* (1999) for some discussions based on equation (2.1) in the context of zero-interest-rate policy.

[13] Even though we address a reduction in nominal long-term interest rates through monetary policy treating the expected inflation rate as given, it is deemed as necessary to mention that if changes in monetary policy in fact lead to some extent to an increase in the expected inflation rate, then the stimulative effects on aggregate demand through a decline in real interest rates will be more effective than those from a decline on a nominal basis.

reflecting factors such as uncertainty with respect to the future expected short-term interest rates[14]. The risk premium may comprise the following: (i) uncertainty with respect to future short-term interest rates stemming from an unexpected economic shock (be it demand or a supply shock), (ii) uncertainty with respect to future short-term interest rates stemming from the non-transparency of monetary policy management irrespective of the treatment of economic shocks as given), and (iii) effects of bond prices (long-term interest rates) being affected according to the supply of long-term government bonds because of market segmentation[15]. From the above three only (ii) and (iii) can be influenced by the monetary policy management (Oda and Okina (2001), p. 333-334).

*(b) The channel of relative prices*, which is also sometimes called the 'asset price channel', which is presented in two different versions in the literature, namely the 'monetarist' version and that developed by Tobin (1969), assumes that central banks influence the composition and/or prices of the assets which are held in the portfolios of economic agents. An unexpected monetary policy impulse disturbs the equilibrium composition of the portfolios and induces attempts to adjust their

[14] In fact, as explained in Oda and Okina (2001) when, for example, the central bank announces that it will stick to a zero interest rate policy until deflationary concerns are dispelled, a deterioration in the economic outlook leads to an expectation of $E_t$ $(r_{t+i})$ = 0 that zero rates will hold longer than previously expected, i.e., $i$ will increase, and thus $R_t$ will decline. Conversely, if strong expectations for economic recovery come into presence, the expected timing of the termination of the zero rate policy will be brought forward and increasing thus $R_t$, and eventually exerting downward pressure on demand. Monetary easing, in this case, has worked both by achieving zero interest rates and by influencing the interest rate channel through expectations about the duration of zero interest rates (Oda and Okina (2001), p. 333).

[15] Since doubt is cast by several empirical results (see Shiller (1990) for a survey) on the validity of the premise underlying the model in equation (2.1), which is the market segmentation hypothesis, for the point in (iii) to hold, it is assumed that the flow of funds model follows the preferred habitat hypothesis. Cuthbetson and Nitzsche (2004) concisely state the basis of the former to be the fact that "the term premia depend on the proportion of wealth held in long debt" and consider the latter based on the proposition that "since bonds that mature at dates that are close together should be reasonably close substitutes they tend to have similar term premia" (Cuthbertson and Nitzsche (2004), p. 497).

composition. Ultimately, an expansion of the monetary base by open market operations leads to more demand for securities, to rising security prices and thus falling interest rates and possibly also to an increase in consumption and investment expenditure. The extent to which these effects on asset prices merely lead to price-level changes, or also to real effects, depends on the rigidity of prices and the 'disturbances' which may arise from changes in the expectations concerning the future monetary policy. The two versions mentioned above according to Schmidt (2001) "differ with respect to the asset categories which the agents try to bring into balance, and their respective rates of return and also as regards the extent to which the process of the restructuring portfolios directly affects the demand for real versus financial assets and thus investment decisions" (Schmidt (2001), p. 211-212).

More specifically, let us suppose that a central bank increased the outright purchase of long-term government bonds[16], increasing the supply of base money and reducing government bonds outstanding in the market with a medium to long term remaining period until maturity i.e. from one to ten years. This will result in the portfolio rebalancing for individual economic entities, leading to the decline in long-term interest rates following a fall in risk premium due to supply and demand factors and other effects on various asset markets[17]. Moving towards equilibrium, there would be

[16] According to Oda and Okina (2001) referring to channels based on portfolio selection theory, not only the case where a central bank trades long-term government bonds but also cases where other types of assets such as corporate bonds, CP, stocks, and real estate are traded can be considered. If we are to evaluate the validity of such policies, we need to address the issue to what extent risk can be shouldered by a central bank while ensuring its asset soundness. Yet the specific evaluation of the risks attached to individual assets is beyond the scope of the thesis. Nevertheless, one needs to note that there might be quite a substantial social cost that would even erode the mechanism of capitalism when the public sector and a central bank shoulder private-sector credits in an extremely large amount (Oda and Okina (2001), p. 334).

[17] See Meltzer (1995, 1998, 1999).

an increase in stock prices (Tobin's *q* would increase[18]) and investment expenditure would be stimulated, since there would be a move in the stock market to convert cash into stocks. If we focus on the loan market and the corporate bond market, investment would be stimulated through a decline in credit premium and new loans would increase. There will be new demand effects in the real estate market and other markets through a similar mechanism. All these are transmission effects of medium to long term operations, where tightened supply and demand conditions in the bond market have an impact on several other financial markets, tightening respective supply and demand conditions, and resulting to a new equilibrium price and asset balance.

Oda and Okina (2001) stress that "according to general equilibrium analysis, such effects can be expected to be obtained qualitatively. However, in order to consider over what time span and in what manner a new equilibrium might be realized in actual respective markets, several factors are important. First is the amount of outright purchase of medium- to long-term government bonds necessary for changing equilibrium to any significant degree. In order to consider this, we need to compare effects accompanying the operation and the potential costs. The second factor is the magnitude of portfolio rebalancing activity according to the risk-return profile of fund providers such as financial intermediaries and investors" (Oda and Okina (2001), p. 334-335).

According to the proponents of the asset price channel, the main instrument of the central bank is its influence on the quantity of central bank money in the economy.

[18] See Mishkin (1995), p. 6, for a concise presentation.

This suggests that different procedures in which central banks operate in practice, and, in particular, differences in terms of the types of financial assets which are eligible as reserves, may lead to differences in the effectiveness of monetary policy. However, even also including the United Kingdom, the differences between the various economies in Europe which existed in these respects in the past, are giving way to a common approach [19]. Another aspect, and one in which the various European economies still differ considerably and which is important for this channel, is the extent to which the agents hold financial assets whose prices may vary in reaction to central bank policy. The larger the share of such financial assets in agents' portfolios, the greater will be the likelihood that central bank impulses will work in the ways postulated by the advocates of the asset price channel[20] (Schmidt (2001), p. 212).

Naturally, it is money that lies behind the transmission mechanism outlined above in the sense that central banks use open-market operations (especially repurchase contracts) to influence the supply of reserves and as such provide the reserves demanded at the desired level of the instrument rate (an operating target), an overnight rate or a very short-term (two weeks for example) repurchase rate. Following this rationale it is suitable to think of the instrument rate as the central-bank instrument and consider reserves to be demand-determined.

However, as Svensson (2001) highlights "the direct money channel, is something different than supplying reserves to achieve a particular level of the instrument rate

[19] See Borio (1997) for an exhaustive analysis of different monetary policy procedures and their recent convergence.

[20] See Meltzer (1995).

and, in fact, it involves broad money rather than the monetary base" Svensson (2001), p. 283). Nelson (1999) and Meltzer (2001) give empirical support for a direct effect of real money on aggregate demand, in addition to the effect via the interest rate. Such an effect might be expected to show up as real money, in addition to the other variables (see Svensson (2001), pp. 283-289). Woodford (2003) underlines the extent that such an effect is interpreted as a wealth effect. As analysed in Nelson (1999), McCallum (1999), and Woodford (2003, Chapter 2) for a direct money effect to arise, real balances should enter the representative agent's utility function and this utility function must not be additively separable in consumption and real balances but have a positive cross-derivative. Nevertheless, reasonable parameter values make any such effect small enough that it can safely be disregarded. Nelson (1999) and Meltzer (2001) stress that a direct effect of money may instead stand as a proxy for effects of asset prices and interest rates other than the short nominal interest rate, with particular mention to the long-term bond rates. However, if this is the reason for a direct money effect, it seems more satisfactory to include in a model explicitly those asset prices and interest rates (Svensson (2001), p. 291).

### *2.4.3. The exchange rate channel*

Only a brief mention to the exchange rate channel is deemed appropriate since the focus of the thesis is not on an open economy. In fact, if the nominal exchange rate of the domestic currency can be depreciated through foreign exchange intervention in a stable manner, the real exchange rate will also depreciate[21] given that in the short-term prices remain unaltered, leading to a higher level of exports and stimulating, thus, aggregate demand. As pointed out by Oda and Okina (2001) “while there is a constraint in terms of foreign currency reserves when the authorities intend to effect the appreciation of their home currency, as long as they tried to see a depreciation there would be no constraints since, in principle, they can issue money in unlimited amounts to buy foreign currency”. Therefore, they contend that unless intervention is countered by intervention in the opposite direction from counterpart countries the domestic currency would eventually depreciate through portfolio rebalancing effects (see also Bernanke (2000)). Furthermore, market participants, noticing such intervention, would forecast the authorities’ target exchange rate and duration of intervention policy and, eventually, form their foreign exchange transactions based on these forecasts[22] (Oda and Okina (2001), p. 338-339).

#### *2.4.4. The credit channel*

The credit view stresses the distinct role played by financial assets and liabilities. Rather than aggregate all non-money financial assets into a single category called bond, the credit view argues that macroeconomic models need to distinguish between different non-monetary assets, either along the dimension of bank versus non-bank

[21] A broad survey of empirical studies is given by Froot and Rogoff (1995) on the extremely slow regression speed of the real exchange rate (namely the purchasing power parity [PPP] puzzle). They state that the consensus among major industrialized countries was that once real exchange rates diverge from PPP it takes about four years to recover half the divergence. It is, therefore, possible to assume, a case in which the real exchange rate is not thoroughly adjusted. For the PPP puzzle, see also Rogoff (1996).

[22] See for example Meltzer (1999), for a theoretical argument that an introduction of a temporary “fixed” foreign exchange rate system can have certain effects under a zero interest rate policy.

sources of funds or along the more general dimension of internal versus external financing. The credit view also highlights heterogeneity among borrowers, stressing that some borrowers may be more vulnerable to changes in credit conditions than others. Finally, investment may be sensitive to variables such as net worth or cash flow if agency costs associated with imperfect information or costly monitoring create a wedge between the cost of internal and external finance. A rise in interest rates may have a much stronger contractionary impact on the economy if balance sheets are already weak, introducing the possibility that nonlinearities in the impact of monetary policy may be important (Walsh (2000), p. 286).

At the heart of the credit channel are those aspects which are largely left out by the two traditional channels. Because of the information and incentive problems which are widely discussed in the current corporate finance literature, financial systems do not function in a frictionless manner, and for many non-financial firms external financing is simply difficult to obtain and more costly that internal financing. The cost difference is called the 'external finance premium'. In the relevant theoretical and empirical literature this external finance premium is assumed to be not only an expense incurred in addition to the basic interest costs, but also a positive function of the interest rate. In other words, if the central bank raises or lowers' the interest rate', the external finance premium will also go up or down[23].

Indeed, there is a difference (which has been termed as above the external finance premium) between the cost of external financing (equity and debt) and that of internal financing (retained earnings), stemming from the existence of an agency cost

[23] Bernanke, Gertler and Gilchrist (1996) and Kashyap and Stein (1997b) give surveys of this channel and provide relevant empirical results for the United States.

due to information asymmetry with respect to corporate management information within and outside a firm. After a fall in short-term interest rates, the external finance premium declines, facilitating thus corporate external financing, and giving rise to demand stimulating effects other than through the interest rate channel (Bernanke and Gertler (1995)). Considering, in turn, a decline in the external finance premium, we need to point that a fall in the interest rates improves a firm's financial position, a central bank's increased supply of reserves improves lending capacities of banks, and the private sector's increased collateral value stemming from a rise in asset prices reduces premiums at the time of bank lending. With respect to lending capacity, it is a mechanism that functions when banks' ability to provide funds from the market is constrained compared with fund demand. Yet, the asset price effect would intensify the policy effects through interest rate, portfolio rebalancing, and foreign exchange channels. So long as these channels function, the market is going to expect a rise in asset prices, and this shift in expectation would actually result in a rise in asset prices. However, the credit channel will function on its own unless we assume an extreme case[24] where asset prices rise in a self-fulfilling manner (Oda and Okina (2001), p. 336-337).

Another aspect which is highlighted in the credit channel view of the transmission mechanism comprises the availability of bank credit and the specific quality – i.e. the limited substitutability – of bank credit. Working in combination, the external

[24] Be it a portfolio rebalancing channel or a foreign exchange channel, it is worth noting that if a central bank does not seize to implement additional measures on a massive scale, asset prices may possibly increase in a self-fulfilling manner to a level beyond fundamentals. In this case of a bubble generated, effects through the credit channel would be amplified compared to those in the normal case. It is needless to say though that it is impossible to control the size and timing of the generation and bursting of a bubble and, therefore, it is difficult to design monetary policy management in a manner that anticipates such effects. Further analysis on this follows in Chapters 5 and 6.

finance premium and the availability of bank credit strengthen the effectiveness of monetary policy considerably, and it seems thoroughly plausible to assume that these two factors may differ much more between countries than those at which the traditional views of the transmission mechanism focus (Schmidt (2001), p. 213).

Another distinction of the credit channel, similar to the above, often distinguishes between a bank lending channel and a broader financial-accelerator mechanism[25]. The bank lending channel emphasizes the special nature of bank credit and the role of banks in the economy's financial structure. In the bank lending view, banks play a particularly critical role in the transmission of monetary policy actions to the real economy. Policy actions that affect the reserve positions of banks will generate adjustments in interest rates and in the components of the banking sector's balance sheet. Traditional models of the monetary transmission mechanism focus on the impact of these interest rate changes on money demand and on consumption and investment decisions by household and firms. The ultimate effects on bank deposits and the supply of money are reflected in adjustments to the liability side of the banking sector's balance sheet (Walsh (2000), p. 286).

The credit channel, however, is usually analysed in terms of two separate but complementary channels. The first one, the broader of the two, is called the 'balance sheet channel', which focuses on the ability to borrow. The external finance premium for a given borrower is determined by its financial position, in particular by its net worth, and the value of the collateral which it can provide. The borrower's financial position is influenced by the monetary policy and by the business cycle. A restrictive

[25] A variety of surveys and overviews of the credit channel are available, see eg. Gertler (1988), Bernanke (1993), Ramey (1993), Gertler and Gilchrist (1993), Kashyap and Stein (1994), Bernanke and Gertler (1995), Cecchetti (1995), Hubbard (1995), and Bernanke, Gertler, and Gilchrist (1996).

monetary policy raises the interest rates, reduces the cash flow of firms and depresses net asset values of borrowers and the value of their collateral, and thus may severely restrict their financing options and raise the premium. The likely consequence is a reduction of investment and in particular of investment in working capital, which is typically financed by short-term bank credit. Owing to economy-wide accelerator effects, the impact of a monetary contraction may not only be stronger, it may also last longer than the traditional view suggests[26] (Schmidt (2001), p. 213).

The effects on banking-sector reserves and interest rates also influence the supply of bank credit, the asset side of the balance sheet. If banks cannot offset a decline in reserves by adjusting securities holdings or raising funds through issuing nonreservable liabilities, bank lending must contract. If banking lending is “special” in the sense that bank borrowers do not have close substitutes for obtaining funds, variation in the availability of bank lending may have an independent impact on aggregate spending. Key then to the bank lending channel is the lack of close substitutes for bank credit on the part of borrowers. Imperfect information plays an important role in credit markets, and bank credit may be “special” that is have no close substitutes, because on information advantages banks have in providing both transactions services and credit to businesses. Small firms in particular may have difficulty obtaining funding from non-bank sources so a contraction in bank lending will force these firms to contract their activities (Walsh (2000), p. 286).

Thus, the other ‘branch’ of the credit channel is usually the more narrowly defined bank lending channel. Its proponents proceed from the highly plausible assumption

[26] See Bernanke, Gertler and Gilchrist (1996).

that the central bank is in a position to limit the quantity of credit which the banking sector can provide to borrowers. A restriction or rationing of bank credit in turn restricts the scope of firm investment; and this is all the more likely the less bank credit can be substituted by other sources of funding at the bank and firm level. In claiming that bank credit is indeed difficult and in some cases even impossible to substitute as it provides a certain liquidity insurance, advocates of the credit channel of the transmission mechanism borrow heavily from the recent advances in the theory of financial intermediation which shows why 'bank loans are unique'[27]. Banks are specialists in lending to firms in those cases in which it is important to monitor the borrower carefully – or, in other words, in overcoming information and incentive problems (Schmidt (2001), p. 213).

However, the broad credit channel is not restricted to the bank lending channel. Credit market imperfections may characterise all credit markets, influencing the nature of financial contracts, raising the possibility of equilibria with rationing, and creating a wedge between the costs of internal and external financing. This wedge arises because of agency costs associated with information asymmetries and the inability of lenders to monitor borrowers costlessly. As a result, cash flow and net worth become important in affecting the cost and availability of finance and the level of investment spending. A recession that weakens a firm's sources of internal finance can generate a 'financial-accelerator' effect; the firm is forced to rely more on higher-cost external funds just at the time the decline in internal finance drives up the relative cost of external funds. Contractionary monetary policy that produces an

[27] For an overview see Freixas and Rochet (1997). More recent contributions include Rajan (1996) and Kashyap, Rajan and Stein (1999). The quotation paraphrases the title of an influential article by James (1987).

economic slowdown will reduce firm cash flow and profits. If this policy increases the external finance premium, there will be further contractionary effects on spending. In this way, the credit channel can serve to propagate and amplify an initial monetary contraction. Financial-accelerator effects can arise from adjustment of asset prices to contractionary monetary policy. Borrowers may be limited in the amount they can borrow by the value of their assets that can serve as collateral. A rise in interest rates that lowers asset prices reduces the market value of borrowers' collateral. This reduction in value may then force some firms to reduce investment spending as their ability to borrow declines (Walsh (2000), p. 287).

The balance sheet channel and the bank lending channel, moreover, interact in such a way that the effects of monetary policy on the ability of firms to borrow from banks and on the ability of banks to lend reinforce each other. This makes their relevance for the effects of monetary policy all the greater. As these brief explanations suggest, it would be wrong to consider the credit channel as an outright alternative to the interest rate channel. Instead, the effects of borrowing capacity and the availability of bank credit which this channel emphasises reinforce those effects which have traditionally been assumed to exist and to underlie the transmission of monetary policy into the real economy. But for practical monetary policy it is important to know more than merely that monetary policy has an effect. One needs to know why it matters and how it affects the real economy in order to be able to determine the direction and the strength of policy measures (Schmidt (2001), p. 214).

For example, it is important to recognise that credit rationing is sufficient but not necessary for a credit channel to exist. A theme of Gertler (1988), Bernanke (1993), and Bernanke and Gertler (1989) is that agency costs in credit markets will vary counter cyclically. A monetary tightening raises interest rates, and generates a real economic slowdown resulting eventually in the deterioration of firm balance sheets, raising agency costs and lowering the efficiency of credit allocation.

Changes in credit conditions are not reflected solely in interest-rate levels. Thus, the general issue is to understand how credit market imperfections affect macroeconomic equilibrium and the channels through which monetary policy actions are transmitted to the real economy (Walsh (2000), p. 288).

Therefore, the credit channel also operates when shifts in monetary policy alter either the efficiency of financial markets in matching borrowers and lenders or the extent to which borrowers face rationing in credit markets so that aggregate spending is influenced by liquidity constraints. There are several definitions of non-price credit rationing. Jaffee and Russell (1976), for example, define credit rationing as existing when, at the quoted interest rate, the level of the loan supplied by the lender is smaller than the one that the borrower demands. Jaffee and Stiglitz (1990), however, emphasize that such a practice does not deviate from standard price rationing since larger loans face normally a higher default rate and, thus, are issued at a higher interest rate. They, instead, characterise "pure credit rationing" as the case when, among a group of apparently identical agents (households or firms), some receive loans and others do not. Stiglitz and Weiss (1981) define equilibrium credit rationing as present whenever "either (a) among loan applicants who appear to be identical some receive a loan and others t do not, and the rejected applicants would not receive a loan even if they offered to pay a higher interest rate; or (b) there are identifiable groups of individuals in the population who, with a given supply of credit, are unable to obtain loans at any interest rate, even though with a larger supply of credit they would" (Stiglitz and Weiss (1981), pp. 394-395). Walsh (2000) views the "critical aspect of this definition" as the fact that "at the market equilibrium interest rate, there is an unsatisfied demand for loans that cannot be eliminated through higher interest rates" and that "rejected loan applicants cannot succeed in getting a loan by offering to pay a higher interest rate" (Walsh (2000), p. 287).

In a more elaborate model presented in Bernanke and Gertler (1995) and Bernanke, Gertler, and Gilchrist (1998), where the borrowing possibilities of some households and firms depend on collateral they give (their balance-sheet position), agents face marginal borrowing costs exceeding the real interest rate, by an 'external-finance premium' (as mentioned above). If the real interest rate falls, the value of the collateral will increase and thereby allow these agents to borrow at a lower external-finance premium. Aggregate demand is, in this way, stimulated beyond the "pure" real interest rate effect discussed in Svensson (2001a), via a "balance-sheet channel" (Svensson (2001), p. 291). Bernanke, Gertler, and Gilchrist (1998) emphasise that improving balance sheets in addition to higher credit flows may also have significant feedback and magnification effects, which they term the "financial accelerator".

Substantial empirical evidence highlights the importance of both capital market imperfections and firm dependence on bank financing. A summary of two streams of study is given by Kashyap and Stein (1997). The first describes banks as extensively relying on reservable-deposit financing and emphasises that a contraction in reserves leads banks to contract their balance sheets, reducing the supply of loans. The second highlights that a significant number of firms depend on bank lending and are unable to react to the fall in bank lending by accessing different sources of finance. Overall, recent research supports the existence of a lending channel[28] (Cecchetti (2001), p. 176).

Non-bank financial intermediaries (NBFIs) and capital markets constitute the main alternatives to banks. They need to be looked at if we wish to determine the extent to which firms and banks are able to circumvent the effects of a restrictive monetary policy which would be transmitted through the bank lending channel. Finally it would be important to look in detail at the sector of the non-financial firms and at the household sector to assess how the actors in these sectors are affected by monetary policy measures of the central bank (Schmidt (2001), pp. 214-215).

The following Table 2.1 summarises the theoretical framework.

[28] This does not contradict the presence of the traditional mechanisms, operating through interest rates and exchange rates. It is difficult though to isolate the individual importance of the various channels of transmission.

*Table 2.1: Main determinants of the transmission of monetary policy to output*

| |
|---|
| ***Interest rate channel*** |
| *Interest rate pass-through*: A quicker and fuller pass-through from policy interest rates to market and bank lending rates increases the power of transmission. |
| *Interest sensitivity of production:* A higher share of interest-sensitive sectors in GDP strengthens the effect of monetary policy. |
| *Price and wage rigidity:* The more nominal price and wages are rigid, the larger the impact of any given demand fall on output. Real rigidities magnify the effect of nominal rigidities. |
| *Income effect:* The impact of higher interest rate on disposable income depends on households' debt position, the maturity of their interest-bearing assets and liabilities, as well as the pass-through from policy interest rates to average interest rates. |
| *Wealth effect:* The wealth effect on consumption will be stronger in countries where households' wealth is large and held in the form of assets with volatile prices. Given the weight of real assets in total wealth, the size and speed of the response of real estate prices to interest rate changes is also crucial. |
| ***Exchange rate channel*** |
| *Openness to trade:* More open economies experience a stronger reduction in output from a real exchange rate appreciation. In these economies, however, the exchange rate will also have a comparatively larger impact on prices (a positive terms of trade effect), and exports may have a higher import content. |
| ***Credit view: Bank lending channel*** |
| *Impact of monetary policy on loan supply:* A monetary policy tightening may reduce loan supply, especially if bank health is poor. However, banks which have large holdings of securities and or can acquire loanable funds (e.g. by issuing market securities) can keep their loan supply unchanged. |
| *Degree of bank dependence:* A high share of bank loans in business financing and a large number of small firms (which have less alternative sources of finance) would point to a potentially strong bank lending channel. |
| ***Credit view: Balance-sheet channel*** |
| *Size structure of firms:* Smaller firms, more prone to suffer from information asymmetries, are likely to experience a larger increase in the external finance premium (the difference in the cost of external versus internal finance). |
| *Use of collateral:* A monetary tightening that reduces the value of collateral will have a stronger effect where collateral is more extensively used. |
| *Firms' leverage:* Firms in financial distress (e.g. measured by a high ratio of interest payments over operating income), are more likely to suffer from the negative cash-flow impact of higher interest rates. A high leverage ratio may be an indicator of financial distress. On the other hand, it may also suggest ease of financing. |
| *Efficiency of legal system and contract enforcement:* Credit rationing is more likely in countries with inefficient legal systems and weak enforcement of contracts. In such cases, a low level of outstanding credit would suggest liquidity constraints. |

Source: Suardi (2001), p. 8

### 2.4.5 Factors Influencing the Transmission of Monetary Policy

Addressing the speed and intensity of the impact of monetary policy to the real economy, we need distinguish two points.

The first is the transmission from the instruments that are under direct control of the central bank, such as short-term interest rates or reserve requirements, to those variables that affect the non-financial sector most directly, such as loan rates, deposit rates, asset prices and the exchange rate. This relation is shaped primarily by the structure of the financial system. The other aspect is the relationship between financial conditions and the spending decisions of firms and individuals. A key role is assumed, in this case, to the initial financial position of banks, firms, and individuals including the extent of leveraging, the composition and the currency denomination of assets and liabilities, as well as the degree of dependence on external financing, in particular bank financing (Kamin, Turner and Van't dack (1998), p. 16) [29].

### 2.4.6 Unresolved Issues in the Monetary Transmission Process

Certain important aspects of the monetary transmission process still remain rather uncertain and disagreement among academics is present. These include: (i) the effects of monetary policy in high-inflation economies, (ii) the transmission of monetary policy actions to long-term interest rates and asset prices, (iii) the estimation of the tightness of monetary conditions, and (iv) the scope for monetary

[29] For a further extensive discussion of these aspects see Kamin, Turner and Van't dack (1998), pp. 16-45.

policy under fixed exchange rates and financial fragility. In all cases, it is the state of expectations that hugely affect the impact of monetary policy that gives rise to the uncertainties. At present brief reference is only made to (i) and (ii)[30].

*Monetary policy in highly inflationary economies:* Monetary policy in highly inflationary economies may have different effects from those in more stable economies mainly in two aspects: (a) the impact of monetary policy on aggregate demand and (b) the conversion of changes in aggregate demand into changes in output and prices. Considering the first monetary policy will not have as high an impact on aggregate demand in a highly inflationary economy as it would in an economy with low inflation. The level of the real interest rate is very uncertain when inflation is high and variable lessening in this way the importance of the interest rate channel of transmission. In addition, in such a regime, financial instruments tend to be issued in narrower terms to maturity and long-term, non-indexed assets disappear; consequently wealth and asset price effects of changes in monetary policy become much less important. Furthermore, in highly inflationary environments, reductions in bank deposits, as well as banks' desire to match the maturities of assets and liabilities results in restricting the role of bank intermediation in financing consumption and investment to a great extent. As aggregate expenditure does not considerably depend on bank loans, it would not be hugely affected by marginal changes in monetary policy.

[30] See Kamin et al. (1998) p. 47 for further analysis.

Apart from the relation between monetary policy and the level of aggregate demand, high inflation regimes are distinctive with respect to the impact that changes in aggregate demand have on output and inflation.

In industrialised countries that face low inflation, monetary policy changes are considered to have an impact on inflation initially by influencing aggregate demand and employment, and, in turn, result in changes in wages, costs and finally consumer prices. On the other hand, several emerging market economies that have quite recent histories of high inflation, do not give evidence of a positive link between economic activity and inflation[31]. Thus in some cases the short-term Phillips curve might be vertical or even have a negative slope (i.e. higher levels of inflation may result in a contraction in economic activity). According to Kamin et al. (1998) “the verticality of the Phillips curve in such circumstances arises from the hyper-sensitivity of inflation expectations and price determination to changes in the monetary stance and this hypersensitivity, in turn, probably reflects memories of recent episodes of high inflation and monetary instability” (Kamin, Turner and Van’t dack (1998), p. 59).

*Long-term interest rates and asset markets:* The impact that changes in short-term interest rates induced by monetary policy have on long-term interest rates and asset prices is already mentioned as an important part of the monetary transmission mechanism. The expectations theory of the term structure defines long-term interest rates as the average of future expected short-term rates augmented by a risk premium, equity prices as the discounted present value of expected future earnings and real estate prices as expected future rents. The principle of uncovered interest

[31] In Argentina, Mexico and Peru, during the 90’s, peaks in inflation rates were associated with sharp economic contractions, while disinflation programmes were linked to recoveries in output as reported in Kamin et al. (1998).

parity postulates that exchange rates are determined by changes in international interest rate differentials. Short-term interest rate changes will, thus, affect long-term rates and asset prices depending upon how monetary policy influences the path of expected future short-term rates, earnings or rents.

Actually, the effect of policy-induced changes in short-term rates to long-term rates and asset prices has been difficult to predict, even in industrialised countries. This is so as it depends on how the expected future path of short-term interest rates is influenced by a policy step. Much depends on how the action alters market expectations of the need for further measures[32]. In addition, asset prices are also defined through expectations of future macroeconomic performance which have an impact on future short-term interest rates, future earnings and rents. Since it is difficult to accurately predict future macroeconomic variables (not the least after undertaking a significant monetary policy measure), the response of long-term interest rates and asset prices to a change in short-term rates is uncertain indeed. This is, in fact, so since the causality between asset prices and macroeconomic performance runs in both directions (Kamin, Turner, and Van't dack (1998), p. 47-59).

Another issue is that asset market behaviour frequently deviates from the basic expectations model, as, in practice, several asset price movements reflect changing risk premia, speculative bubbles or other factors not obviously related to expected

[32] The Federal Reserve, for example, raised short-term rates in February 1994 which might have been expected to lower long rates on the grounds that it was aiming to contain inflation even before it had started to rise. Yet, long-term rates rose as the market (correctly) predicted further interest rate adjustments in the immediate period afterwards.

future returns[33]. These issues contribute to the uncertainties faced with respect to the appropriate level of asset prices and the potential response of asset prices to monetary policy actions. These issues will be discussed in greater detail in Chapters 5 and 6.

## 2.5 Concluding Remarks

It appears plausible that monetary policy is able to have an effect on the real economy primarily because of interest effects and also, to a certain extent, because of asset price effects. however, the recent empirical literature argues that in reality the effects of monetary policy, in particular those of a monetary contraction, are stronger and of a different pattern than those which could be expected if the interest rate and asset price channels were the only relevant mechanisms, and also that they exhibit a different pattern than the effects one would expect to encounter if these were the only pertinent mechanisms[34]. At a theoretical level, the interest and asset price channels assume that the agents in the economy behave in an overly mechanistic fashion, and fail to address directly the question of how the financial sector, and, in particular, the banks, react to monetary policy impulses. These two weaknesses suggest that looking only at the traditional channels might prevent one from acquiring a deeper

[33] Small groups of players can often have a huge effect in the market. Changes in asset market prices can increase by the raised supply of credit or other financing in the wake of financial reform. Market participants may also lack experience in asset-pricing methods, and even less access to timely and accurate information on the financial condition of firms seeking to raise funds. Moreover, several of these firms may be new, thus, without an extensive track record, which would make them inherently more difficult to price. With reference to several emerging market economies, the unpredictability of asset market responses may be magnified by the greater volatility of macroeconomic performance (including output and inflation) compared with industrialised countries. This increases the number of possible reactions to a given change in short-term interest rates (Kamin, Turner and Van’t dack (1998), p. 50).

[34] See Bernanke and Gertler (1995) for this argument.

understanding of the implications of intercountry differences for a common monetary policy (Schmidt (2001), p. 212).

Many economists, however, have argued that monetary policy has direct effects on aggregate spending that do not operate through traditional interest rate or exchange rate channels, and a large literature in recent years has focused on credit markets as playing a critical role in the transmission of monetary policy actions to the real economy. Money has traditionally played a special role in macroeconomics and monetary theory because of the relationship between the nominal stock of money and the aggregate price level. The importance of money for understanding the determination of the general level of prices and average inflation rates, however, does not necessarily imply that the stock of money is the key variable that links the real and financial sectors or the most appropriate indicator of the short-run influence of financial factors on the economy (Walsh (2000), p. 285).

As emphasized in most of the surveys cited above, the lending view has two main aspects, namely one that focuses on the impact of policy changes on borrower balance sheets and another that focuses on bank loans. In both cases it is capital market imperfections, which make it easier for some firms to obtain financing than others, that determine the effectiveness of policy. Moral hazard problems and information asymmetries, together with bankruptcy laws, imply that a firm's balance-sheet position has implications for its ability to obtain external finance[35]. Policy-induced increases in interest rates (both nominal and real) result in a deterioration in the firms' net worth by reducing expected future sales and by

[35] Kashyap and Stein (1994) point out that this statement applies to both financial and non-financial firms.

increasing the cost of rolling over a given level of nominal debt. Moreover, when there is an asymmetry of information, in that borrowers have better information about the potential profitability of investment projects than do creditors (banks), as a firm's net-worth declines, it becomes less creditworthy because it has extra incentives to misrepresent the riskiness of potential projects; an outcome that will induce potential lenders to increase the risk premium they require when making a loan. Thus informational asymmetry renders internal finance of new investment projects cheaper than external finance (Cecchetti (2001), pp. 175-176).

An important aspect of the transmission mechanism is that some firms dependent on the banking sector for finance and that monetary policy affects the supply of loans from banks. A reduction in the quantity of reserves leads to a reduction in the level of deposits, which in turn has to be matched by a reduction in the level of loans. However, the latter will affect the real economy only if firms do not have access to alternative sources of investment funds.

To sum up the process described in this chapter involves a number of different mechanisms and actions undertaken by economic agents at various stages. Consequently, the monetary policy actions need a considerable time to have an impact on the price developments. Moreover, the size and intensity of the effects can differ with respect to the state of the economy, which renders the estimation of the precise impact considerably difficult. Central banks, thus, are facing long, variable and uncertain lags in the conduct of monetary policy.

A further issue that complicates the transmission mechanism of monetary policy is that, in practice, a large number of shocks from several sources influence economic developments. For instance, changes in oil, other commodity prices or in administered prices may have a direct, short-term impact on inflation, and so may developments in the world economy or in fiscal policies through an effect in aggregate demand. Similarly, financial asset prices and exchange rates are affected by several other factors in addition to monetary policy. Therefore, in addition to monitoring the monetary transmission mechanism central banks need also to consider all other developments relevant for future inflation so as to refrain those from having an impact on longer-term inflation trends and expectations in a way inconsistent with price stability (ECB (2004), p. 47). Monetary policy has always been dependent on the size, nature and duration of the shocks hitting the economy, and understanding the factors driving trends behind price developments in order to find the appropriate monetary policy reaction, has always been a challenge for central banks.

As central banks face a complex environment of economic interactions, they often tend to consider some simple rules of thumb in order to guide or cross-check their action.

# CHAPTER 3

# THE THEORY OF MONETARY POLICY: A CONSENSUS

## 3.1 Introduction

The last three decades have been decisive for the evolution of monetary theory and practice. As far as the practice is concerned, the crucial factor has been the very success of several central banks to actually acquire and maintain credibility for low inflation, and improve for several years the stability of both inflation and output relative to potential. With respect to the theory, the decisive improvement has been the introduction and wide acceptance of rational expectations in the relevant models, as it mainly enabled the incorporation of forward-looking elements of aggregate demand and price-setting in the latter, which also enabled the understanding of the success of monetary policy in practice.

Indeed, huge influence has been exerted to both the theory and practice of monetary policy by the disinflation period (effected in the US and other industrialised economies) in the 1980s and the stabilization of inflation that succeeded it[36]. The exchange of information and expertise among central banking practitioners and academic economists, in addition to the utilisation by both of the immense evidence accumulated during the 'conquest of inflation' constituted a major improvement in the process.

[36] See Fischer (1994) and Blinder (2004), for instance, for extensive accounts.

The shift in the several central banks' focus and decision to act against inflation, has mainly been effected through the reception of monetarist theory and the evidence accumulated on money supply and demand, as well as on the relationship between money and inflation. The consequent success in stabilising and eliminating inflation at reasonable costs in relation to the subsequent benefits (that has been termed the 'Great Moderation' – see eg. Bernanke (2004) for a concise account) effected without wage and price controls and supportive fiscal policy actions[37], justified the messages postulated by monetarist theory. Yet, the subsequent reliance on interest rate policy seems to give no credit to the main monetarist teaching that 'money must play a central role in the execution of monetary policy'. As pointed by Goodfriend (2005) "modern models of interest rate policy owe more to post-monetarist rational expectations reasoning and notions of credibility and commitment to policy rules born of the rational expectations revolution" (Goodfriend (2005), p. 243).

Nevertheless, models of monetary policy currently in use are based on macroeconomic theory developed prior to the early 1980s. For example, the forward-looking theory of consumption and investment remains at the core of the modern theory of aggregate demand, yet the concept of a permanent trade-off between inflation and unemployment is not currently accepted. Keynesian dynamic rational expectations sticky-price models of monetary policy that gained credence in the late 1970s and early 1980s (pioneered, for example, by S. Fisher, G. Calvo and J. Taylor) still constitute the core of models of aggregate supply. The inverse relationship between the output gap and a change in inflation that had been predicted by

[37] The policy against inflation during the 1960s and 1970s (especially in the US) placed the main weight on wage and price controls, in accordance to fiscal policy actions.

Keynesian models had been confirmed by the severe recessions accompanying disinflations in several countries. The following success with respect to price stability has supported the rational expectations idea that when a central bank commits to having a priority of achieving and maintaining low inflation can actually anchor inflation expectations and improve the stability of both inflation and output relative to potential.

## 3.2 The Evolution of the Theory of Monetary Policy in the Last Thirty Years

A comprehensive review of stabilization policy is given by Tobin (1980) who provides an accurate and concise account of macroeconomic theory as it related to monetary policy, unemployment, and inflation at the time. He isolates five main points that constitute what he refers to as the consensus macroeconomic framework. These are the following:

(1) “Prices are marked up labour costs, usually adjusted to normal operating rates and productivity trends…and rates of price and wage increase depend partly on their recent trends, partly on expectations of their future movements, and partly on the tightness of markets for products and labour.

(2) Variations in aggregate demand, whether a consequence of policies or of other events, affect the course of prices and output, and wages and employment, by altering the tightness of labour and product markets, and in no other way.

(3) The tightness of markets can be related to the utilization of productive resources, reported or adjusted unemployment rates, and capacity operating rates. At any given

utilization rate, real output grows at a steady pace reflecting trends in supplies of labour and capital and in productivity. According to Okun's law, in cyclical fluctuations each percentage point of unemployment corresponds to 3 percent of GDP (gross domestic product).

(4) Inflation accelerates at high employment rates because tight markets systematically and repeatedly generate wage and price increases in addition to those already incorporated in expectations and historical patterns. At low utilization rates, inflation decelerates, but probably at an asymmetrically slow pace. At the Phelps-Friedman "natural rate of unemployment," the degrees of resource utilization generate no net wage and price pressures, up or down, and are consistent with accustomed and expected paths, whether stable prices or any other inflation rate. The consensus view accepted the notion of a non-accelerating inflation rate of unemployment (NAIRU) as a practical constraint on policy, even though some of its adherents would not identify NAIRU as full, equilibrium, or optimum employment.

(5) On the instruments of demand management themselves, there was less consensus. The monetarist counterrevolution had provided debate over the efficacy of monetary and fiscal measures, the process of the transmission of monetary policies to total spending, and the proper indicators and targets of monetary policy" (Tobin (1980), pp. 23-25).

As highlighted in Goodfriend (2005) it is remarkable that a great amount of what Tobin (1980) recognised as a consensus is still a basis for modern mainstream models of monetary policy today (Goodfriend (2005), p. 244).

Keynesian economists were considerably sceptical on whether disinflationary monetary policy alone could bring down inflation at an acceptable unemployment cost (as in Okun (1978) and Tobin (1980) for example). The views in Tobin (1980) are worth recalling as they represent a 'pessimistic' side of Keynesian economists thinking with respect to the power of monetary policy to control inflation, and they provide some contrast with monetarist views (see, for example, Friedman (1968), Meltzer (1963) and Brunner and Meltzer (1993)) that gained currency in the inflationary decades prior to the early 1980s.

For instance, Tobin (1980) contended that the path of real variables would have been much worse if the path of nominal GDP growth had stuck to 4 percent per year since 1960. He viewed "the inertia of inflation in the face of non-accommodative policies [as] the big issue." Tobin's opinion was that "the price- and wage-setting institutions of the economy have an inflation bias. Consequently, demand management cannot stabilize the price trend without chronic sacrifice of output and employment unless it is assisted, occasionally or permanently, by direct incomes policies of some kind" (Tobin (1980), p. 64). Tobin further contends that it would be "recklessly imprudent to lock the economy into a monetary disinflation without auxiliary incomes policies" (Tobin (1980), p. 69). Monetarists led by Friedman, Brunner, and Meltzer advocated that central banks (and the Fed, in particular) had the power to use monetary policy alone to bring inflation down and should exercise it. At the core of monetarist theory and its policy recommendations was the quantity theory of money evidence from many countries showing that sustained inflation was associated with excessive money growth, and evidence that inflation could be stopped by slowing the growth of the money supply[38]. They gave support of the stability of the demand for money to a sufficient degree in the United States to enable the central bank to bring the inflation rate down by reducing the trend rate of growth of the monetary aggregates. And they advocated that, even though the introduction of money substitutes could adversely impact the stability of money demand in the short run, money demand was sufficiently stable and money supply controllable enough by a central bank over time that financial innovations will not impact the central bank's power over inflation sufficiently. By providing a convincing body of theory and evidence that controlling money was necessary and sufficient for controlling inflation, and that central banks had the ability to control money, monetarists laid the groundwork for the several central banks to assume the responsibility for inflation and make considerable efforts to bring it down[39].

Nonetheless, both Monetarists and Keynesians projected that a disinflation would be costly. The results of the go-stop policies during the 1950s and 1960s made it clear that there was a short-run unemployment cost of fighting inflation.

The temporary unemployment cost of a large permanent disinflation would tend to be much higher than the cost of previous temporary attempts to contain inflation in the stop phase of the policy cycle. Economists from both strands realised that the unemployment cost of permanent disinflation could be reduced greatly by the monetary authorities' acquiring credibility for low inflation[40]. If disinflation were

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[38] See, Meltzer (1963), Friedman (1968) and (1989), Poole (1978), Sargent (1986), and the reports of the Shadow Open Market Committee led by Karl Brunner and Allan Meltzer.

[39] For the case of the US and the shift in the Federal Reserve's policy see Federal Reserve of St. Louis *Review* (2005), March/April, vol. 87 (2), Part 2.

[40] Fellner (1979), Sargent (1986), and Taylor (1982) discuss the role of credibility in minimizing the cost of disinflation.

credible, money growth and inflation would slow together, with minor increases in unemployment[41].

Conversely, if disinflation were not credible, wage and price inflation would continue as before, and interest rates would be forced upwards and asset prices downwards as the public competed for increasingly scarce real money balances. Unemployment would, then, rise and fall again only as the disinflation became a credible policy, wage and price inflation slowed, interest rates fell, asset prices rose, and aggregate demand rebounded.

The potential role for credibility was more trusted by monetarists as they saw a greater role for expectations in wage and price setting and a smaller role for inertia. Monetarists also saw monetary policy as more apt to exert influence over expected inflation than Keynesians did (Goodfriend (2005), p. 246-247).

According to Goodfriend (2005) a convergence in the theory and practice of monetary policy has taken place since the early 1980s. On the theory side, New Keynesian models, alternatively called New Neoclassical Synthesis models of monetary policy incorporate main aspects from Keynesian, monetarist, rational expectations, and real business cycle macroeconomics. On the policy side, there is a widely accepted desirability and feasibility of central banks to use monetary policy in order to achieve and maintain low inflation over time and that such commitment to price stability enhances the power of monetary policy to stabilize employment over the business cycle. The focus on price stability emerged as a result of the practical

[41] Ball (1994) remarks that a fully credible disinflation could, in fact, increase employment temporarily for some sticky price specifications.

experience in conjunction with theory developed since the late seventies (Goodfriend (2005), p. 250).

### 3.3 Towards a Consensus

The modern 'consensus' macroeconomic model of monetary policy is a dynamic general equilibrium model with a real business cycle core and costly nominal price adjustment[42]. The model and the implications it has for monetary policy are presented, for instance, in Goodfriend and King (1997), Clarida, Galí, and Gertler (1999), Woodford (2003), and Goodfriend (2004)[43] from rather different outlooks, yet with an underlying convergence in thinking. The basis of the model is made of two equations that can be described as follows:

a) A *"forward-looking IS function"* that describes current aggregate demand relative to potential output to be a positive function of expected future income and a negative of the short-term real interest rate. Resembling, though, the original Keynesian IS function, it differs on the inclusion of expected future income. Current aggregate demand depending on expected future income has been postulated early on in the theory of consumption proposed by Fisher (1930) and Friedman (1957).

b) An *"aggregate supply function"* (termed also the price-setting function or the 'Phillips curve') that describes current inflation to be inversely related to expected future inflation and the current output gap (the mark-up in Goodfriend and King

[42] See, for example, for a survey Goodfriend (2004), (2005).

[43] Mankiw and Romer (1991) and the papers therein also give clear presentations of the relevant model.

(1997)). This aggregate supply function can be derived directly from Calvo’s (1983) staggered price-setting model and is closely related to the pioneering work of Fischer (1977) and Taylor (1980)[44].

The very introduction of expected future income in the IS function and expected future inflation in the aggregate supply function accounts for the impact of rational expectations in macroeconomics as introduced, for instance, by Lucas (1976), (1981).

The rational expectations theory and the relevant solution methods constituted a manageable and intuitive approach of modelling expectations. It also highlighted the critical importance for monetary policy analysis of the formation of expectations in a way that rationally reflects changes in the way that monetary policy is imagined to be conducted.

Solving the IS function forward, one can express current aggregate demand relative to potential with respect to the expected path of future short-term real interest rates and future potential output. Price-level stickiness enabling monetary policy to exert leverage over the path of real interest rates, then current and expected interest rate policy actions can determine current aggregate demand.

Solving the price-setting function forward, we can describe the current inflation rate to depend inversely on the path of expected future output-gaps. It is implied by the model that inflation will remain low and stable provided that monetary policy affects aggregate demand so as to stabilize the output gap, to keep the average mark-up at the profit maximizing mark-up. Monetary policy maintains price stability by

[44] See Taylor (1999).

anchoring expected future mark-ups at the profit-maximizing mark-up so that firms are reluctant to alter their prices. For monetary policy that stabilizes the mark-up at its profit-maximizing value the macroeconomy follows the underlying core real business cycle model with flexible prices. According to this viewpoint, "flexible price real business cycle models of aggregate fluctuations are of practical interest, not as descriptions of what aggregate fluctuations should be like regardless of the monetary policy regime, but as descriptions of what they would be like under an optimal monetary policy regime"[45] (Woodford (2003), p. 410).

Recalling the account of the 'consensus' in monetary policy and theory as in Tobin (1980), several aspects are still the same. According to Goodfriend (2005) "there is [still] the idea that prices are marked up over costs; that price trends depend on expectations and on tightness of labour and product markets; that variations in aggregate demand alter inflation by influencing the tightness of markets; that there is a natural rate of unemployment (where output equals potential) at which wage and price setters perpetuate the going rate of inflation (presumably at the profit maximizing mark-up); that inflation accelerates when output is expected to exceed potential (the mark-up is expected to be compressed); and that inflation decelerates when output is expected to fall short of potential (the mark-up is expected to be elevated)" (Goodfriend (2005), p. 251). He further recognises the main advances since then to stem from "the proven power of monetary policy to reduce and stabilize inflation and inflation expectations at a low rate and, also, the progress in modelling expectations rationally to understand how monetary policy consistently committed to stabilizing inflation can achieve favourable results" (Goodfriend (2005), p. 251).

[45] Goodfriend and King (1997) and Goodfriend (2004) and (2005) also emphasize this point.

The final element of the model of monetary policy is a description of how policy is imagined to be conducted. According to the rational expectations theory the way monetary policy influences behaviour can only be described when modelled as part of systematic policy. Thus, it has to be specified in the model how policy is conducted. The two ways employed involve either the use of a rule guiding the policy instrument – the most common case being a Taylor-type interest rate rule (see Taylor (1993)) – or the choice of the central bank instrument each period using the maximisation of a welfare function (which can be derived to reflect household utility).

Naturally, there are advantages and disadvantages in either way employed. A policy rule (set on an ad hoc basis) even though it is easy as a reference point and may be selected to approximate the reaction function of a central bank in practice, it is unlikely to be optimal in the model in question. Conversely, if the model is incorrect the results will not be optimal for policy in practice and even if it is not mis-specified it may still yield an optimal rule that will not be followed in practice[46]. As it was first emphasized by Kydland and Prescott (1977), optimal monetary policy may be time inconsistent and monetary policy may be suboptimal unless the central bank commits to a specific rule[47] (Goodfriend (2005), p. 250-251).

McCallum (2005) briefly contrasts models that are currently being used for monetary theory and policy similar to the consensus model discussed above, with the ones that were used during the early 1980s and provides lessons to be learned from the advancements made since. A model that he uses so as to illustrate the broadly

[46] See Svensson (1999a) and McCallum (1999a).

[47] See Barro and Gordon (1983a) and (1983b).

approved views of the time is the one in McCallum (1980), which was designed to demonstrate the effects of introducing rational expectations into a mainstream macroeconomic model[48] (McCallum (2005), p. 287).

A number of researchers such as Lucas (1973), Fischer (1977), Sargent (1973), Taylor (1979), and McCallum (1980) conducted rational expectations analysis in order to derive the dynamic properties of several systems and alternative monetary policy rules. At the core of that analysis was whether, under rational expectations, it was the systematic components of monetary policy rules (rather that the random ones) that produce an effect on the cyclical properties of the real variables, including employment and the output gap (McCallum (2005), p. 287).

Lucas (1972), (1973), Sargent (1973), and Sargent and Wallace (1975) argued that alternative monetary policy rules would leave the behaviour of the output gap unaffected, while Fischer (1977) and Taylor (1979) advocated for the contrary. McCallum (1980) reached the conclusion each position could be supported by

[48] He actually considers the following basic model (admitting the fact that it may still not be the most representative of the time) (taken from McCallum (2005), p. 287):

(1) $y_t = b_0 + b_1\left(i_t - E_t\Delta p_{t+1}\right) + v_t \qquad b_1 < 0,$

(2) $\Delta p_t = E_{t-1}\Delta p_t + \alpha_1\left(y_t - \bar{y}_t\right) + \alpha_2\left(y_{t-1} - \bar{y}_{t-1}\right) + u_t \qquad \alpha_1 > 0,\ \alpha_2 < 0,$

(3) $m_t + \mu_0 + \mu_1 m_{t-1} + \mu_2\left(y_t - \bar{y}_{t-1}\right) = e_t \qquad \mu_1 > 0, \mu_2 < 0,$

(4) $m_t - p_t = c_0 + c_1 y_t + c_2 R_t + \eta_t \qquad c_1 > 0, c_2 < 0,$

(5) $\bar{y}_t = \gamma_0 + \gamma_1\bar{y}_{t-1} + a_t \qquad \gamma_1 > 0.$

Here the symbols are as follows: $y_t$ = log of output, $\bar{y}_t$ = log of natural-rate output, $p_t$ = log of price level, $m_t$ = log of money stock, $i_t$ = one-period interest rate, and $v_t$, $u_t$, $e_t$, $\beta_t$ , $a_t$ = stochastic shocks. Equation (1) is an IS function in which the rate of spending on goods and services depends (negatively) on the real rate of interest. Equation (2) is a “natural rate” type of Phillips curve or price adjustment relationship, with a unit coefficient on $E_{t-1}\Delta p_t$ implying the absence of any long-run trade-off, as in Fischer (1977) or Lucas (1973). In addition, (4) is a money demand (or “LM”) function of a standard type, while (3) represents monetary policy behaviour with the central bank adjusting the money supply each period in a way that responds to the current (or possibly a recent past) output gap. Researchers concerned with operationality, such as Andersen and Jordan (1968) and Brunner and Meltzer (1976), tended to use the monetary base as the instrument variable in policy specifications that would be represented by (3) in the model. The output gap refers to the fractional difference between output and its natural rate value, with the latter being generated (exogenously, for simplicity) in equation (5).

plausible specifications. McCallum (2005) recollects that "most policy analysis conducted at the time was not of this type, focusing on properties of dynamic systems, but instead featured point-in-time exercises of the type that rational expectations analysis showed to be (in many cases) fundamentally misleading" (McCallum (2005), p. 287). Currently, the standard mode of policy analysis employs a comparison of the behaviour of target variables (such as inflation and the output gap) under different maintained policy rules, rather than point-in-time exercises[49].

According to McCallum (2005) there is another aspect in which current policy analysis has evolved in a different direction, besides the uncontested use of the short-term interest rate as the monetary policy instrument and the neglect of the use of the monetary base. This is that recent models tend to employ optimisation-based general equilibrium analysis in an attempt to develop systems that are potentially structural and thus do not fall in the Lucas critique (as in Lucas (1976)) and also be specified quantitatively, either in terms of an econometric estimation or of careful calibration of their parameter values (the latter as emphasized in the real business cycle literature) (McCallum (2005), p. 288).

Nonetheless, a considerable number of vital issues concerning what we termed the 'consensus' approach to modelling monetary policy actions still remain controversial. Those refer, for example, to the theory of monetary policy, inflation targeting, interest rate policy, and communications. A concise discussion of some of these is deemed necessary.

[49] McCallum (2005) suggests that he would also include the design of optimal policy rules under the advances, despite various reservations mentioned in McCallum and Nelson (2004).

The part of the theory of monetary policy that seems to give rise to the most significant controversies is the price-setting function as it defines the nature of the short-run trade-off between inflation and unemployment [50]. Aggregate-demand shocks pose no problem with respect to the stabilisation of inflation around its objective and of output around potential (as the effort to counter the shock works towards the desirable directions). This does not apply to aggregate-supply shocks, however. To appreciate these issues, it is worth to address the price-setting function as derived from Calvo (1983), according to which the current level of inflation depends positively on expected future inflation and inversely on the current output gap.

As it is emphasized by Goodfriend and King (1997), (2001), King and Wolman (1999), and Goodfriend (2002), in this baseline case, fully credible price stability (implying that current inflation equals expected future inflation and is consistent with a low inflation target) keeps output at its potential and employment at its natural rate. Even for aggregate-supply shocks, the function does not support the existence of short-run trade-off between inflation and unemployment. Following this view, even those who care mainly about output and employment can opt for strict price stability (Goodfriend (2005), p. 254).

However, opposing views refer to the baseline case as unrealistic and advocate that by incorporating other potential features of the macroeconomy into the model, one can discredit the result that price stability is always the welfare-maximizing monetary policy. Taylor (1999a), for example, (and the papers therein) presented a

[50] The aggregate supply function that uses the Calvo (1983) staggered price-setting justification presents a small long-run trade-off between unemployment and inflation which is, in fact, ignored in practical applications.

trade-off in the long-run variance of inflation and output relative to potential in models of monetary policy that resulted from a short-run trade-off in the levels of inflation and unemployment. According to Goodfriend (2005) "any of the following modifications of the Calvo price-setting function produce a short-run trade-off in inflation and unemployment, i.e. adding (i) a "cost" shock that feeds directly into inflation irrespective of expectations or the current mark-up, (ii) lagged inflation that reflects structural inflation inertia in the price-setting process, and (iii) nominal wage stickiness to the baseline model, which otherwise presumes that wages are perfectly flexible" (Goodfriend (2005), p. 254). By carrying out any of the above modifications, to stabilize both inflation and output at potential is not always possible and, thus, monetary policy must create a shortfall of aggregate demand relative to potential output to offset the effect of a cost shock or inertial inflation on current inflation. In addition, nominal wage stickiness creates a trade-off with respect to productivity shocks even without modifications (i) and (ii)[51] (Goodfriend (2005), p. 254).

Even though the above modifications seem realistic, their practical importance is still questioned[52]. Ball (2005) remarkably asserts that "it seems that economists were

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[51] To illustrate this, Goodfriend (2005) gives the example of a temporary negative shock to productivity in the baseline model. In that case, both output gap and inflation stabilization call for a contraction in aggregate demand to conform to the contraction in potential output. Nominal and real wages both fall with productivity, offsetting the effect of the negative shock to productivity on marginal cost and the mark-up. Thus, when wages are flexible, monetary policy can simultaneously stabilize the output gap and inflation. Yet, if nominal wages are sticky (see Erceg, Henderson, and Levin (2000)), monetary policy must steer aggregate demand below potential (to raise the marginal physical product of labour) to offset the effect of negative productivity growth on marginal cost in order to stabilize the mark-up and the inflation rate (Goodfriend (2005), p. 254).

[52] First, strictly speaking, a 'cost' shock cannot be included in the price-setting function marginal cost is already taken into account in the underlying theory. The statistical residual found in practice may only be the result of mismeasurement or noise in the modelling of expectations. If one argues that some costs flow directly to prices in a perfectly competitive sector, then theory suggests that the central bank should consider stabilizing only a 'core' index of monopolistically competitive sticky

confused during the 1960s, as they believed in a long-run trade-off between output and inflation and advanced non-monetary theories of inflation and some, for example, suggested that inflation was caused by greedy firms and labour unions, whose behaviour could not be controlled by the monetary authority" (Ball (2005), p. 263), (on the latter see Nelson (2004)). Friedman, though, advocated that 'inflation is always and everywhere a monetary phenomenon'. In Friedman (1968) he provides an explanation that the output inflation trade-off exists only in the short run, while in the long run, unemployment must eventually reach its natural rate. Friedman's ideas controversial, though, they where when they were first expressed, they soon gained wide acceptance influencing policymakers in addition to academics.

Friedman (1968), in particular, not only gave general principles about the economy, but also included a precise theory of the Phillips curve. Concisely the latter was presented using the statements that "there is always a temporary trade-off between inflation and unemployment and that there is no permanent trade-off" (quoted in Ball (2005), p. 263). The temporary trade-off is generated from unanticipated inflation, which means, in general, a rising rate of inflation. Ball (2005) gives the following equations to express Friedman's verbal statements. The relation between unemployment and surprise inflation is described by the expectations augmented Phillips curve:

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prices. Second, as argued in Furhrer and Moore (1995), theory that justifies structural inertia in the inflation-generating process is controversial. Lags of inflation in an estimated inflation-generating function could reflect persistence introduced into the inflation rate by central bank behaviour, in particular in the case of measurement or other specification errors. Cecchetti (1995a) and Cogley and Sargent (2001), for example, give evidence that apparent inflation persistence is reduced when inflation is low and stable. Third, an inflation target of 1 to 2 percent along with productivity growth of around 2 percent produces nominal wage growth in the 3 to 4 percent range. Average nominal wage growth that is as high should keep the economy away from situations in which significant downward nominal wage stickiness, as opposed to slower nominal wage growth, is required to keep price inflation stable and output at potential (see Goodfriend (2005), p. 255).

$$\pi_t = E_{t-1}\pi_t - \alpha\left(u_t - \bar{u}\right),$$

where $\bar{u}$ is the natural rate of unemployment. The fact that unanticipated inflation and rising inflation come to employ the same meaning implies that expectations are backward-looking (i.e. $E_{t-1}\pi_t = \pi_{t-1}$). Inserting the latter relation into the previous equation, one yields the "accelerationist" Phillips curve, which relates unemployment to the change in inflation and has the following form:

$$\pi_t = \pi_{t-1} - \alpha\left(u_t - \bar{u}\right).$$

According to Ball (2005), four decades after Friedman formed his theory, his Phillips curve is still the best simple theory of the unemployment-inflation trade-off" (Ball (2005), p. 264).

Even though the introduction of rational expectations constitute a decisive advancement especially on the monetary theory side, implying a key role for central banks' credibility as inflation fighters[53], Ball (2005) questions the usefulness of rational expectations models for understanding inflation in the real world and projects several related reasons.

He, first, considers the broad history of U.S. inflation since 1979 and claims that the accelerationist Phillips curve still seems the best tool for this job. That is, changes in inflation are well explained by short-run movements in unemployment. In fact, the deep recession of the early 1980s caused inflation to fall sharply. Inflation rose a bit in the late 1980s as unemployment fell. And inflation fell moderately during the

[53] In rational expectations models, an increase in credibility shifts the output-inflation trade-off favourably. A major goal for policymakers is, thus, to build credibility.

recessions of the early 1990s and 2000s. Credibility being really important, shifts in inflation would not be explained by unemployment (or obvious supply shocks). In these episodes, changes in credibility would shift the short-run Phillips curve, which has not been the case in countries with moderate inflation. Ball (2005) recalls that "when Sargent (1983) looked for an example, he had to go back to France in the 1920s - and even this case is disputed by historians. The concept of credibility is not useful for explaining the history of inflation" (Ball (2005), p. 264).

The presence of credibility effects has been researched in various ways, albeit with negative results. Some examples include the following:

• Inflation expectations in the U.S. consistently follow actual inflation with a lag. No unusual episodes can be explained by credibility effects.

• In theory, greater credibility reduces the cost of disinflation, the sacrifice ratio. In practice, Ball (2005) claims that this is not the case. Sacrifice ratios are found by Debelle and Fischer (1994) to be higher for central banks that have a higher level of independence, and, are, thus, more credible. Sacrifice ratios are found to be especially high for Germany under the Bundesbank. Zhang (2001) finds the sacrifice ratio for the U.S. disinflation of 1990-94 was high compared to previous U.S. disinflations, despite the building-up of credibility by the Federal Reserve under Chairmen Volcker and Greenspan.

• Past the adoption of inflation targeting by several central banks (during the last two decades), with the consequent increase in credibility and anchoring of expectations, cross-country comparisons still produce little evidence that inflation targeting changes the behaviour of output or inflation (see Ball and Sheridan (2005)).

Currently, economists have converged on a specific model of the economy, which is, as stated above, “a dynamic general equilibrium model with a real business cycle core and costly nominal price adjustment”, and uses the Calvo (1983) specification of staggered price setting. The Phillips curve produced by the model is of the following form:

$$\pi_t = E_t \pi_{t+1} - \alpha \left( u_t - \overline{u} \right).$$

This equation lies at the core of the New Synthesis model, yet for the purposes of monetary policy, the model faces the problem of being counterfactual[54].

Mankiw (2001) demonstrates that, in the model, a monetary contraction that reduces inflation also causes an output boom, which is the opposite of the common empirical result that reductions in inflation give rise to recessions. The source of the theoretical result lies in the fact that the Phillips curve includes current expectations of future inflation, not past expectations of current inflation. In any case, the model’s “absurd” predictions make it a poor tool for policy analysis (Ball (2005), p. 264).

As Goodfriend (2005) discusses, researchers have tried to fix the New Synthesis model by, among other efforts, adding cost shocks or combining rigidity in wages and prices. In most cases, as Ball (2005) stresses, the trade-off between output and inflation still has the wrong sign. Apparently, the main thing that works is adding lagged inflation to the Phillips curve[55], yet the New Synthesis model does not justify

[54] Kenlow and Kyvstov (2005), Golosov and Lucas (2005) and Gertler and Leahy (2006) provide recent formulations of the price-setting function different from the one proposed by Calvo (1983).

[55] Gaspar and Kashyap (2006) briefly summarise the findings of the Eurosystem Inflation Persistence Network and state that no evidence is found of mechanical indexation to past inflation, undermining thus, the inclusion of lagged inflation in the Philips curve (Gaspar and Kashyap (2006), p. 96).

this term. Adding it, though, "is equivalent to ignoring the model and going back to the accelerationist Phillips curve" (Ball (2005), p. 277).

It is worth recalling, though, that during the late 1960s and 1970s, "both academics and policymakers did not fully understand or appreciate the determinants of credibility and its link to policy outcomes, even though central bankers have long recognized at some level that the credibility of their pronouncements matters" (Bernanke (2005), p. 278). A seminal approach of these issues was provided by Kydland and Prescott (1977)[56]. They demonstrated that when policymakers credibly commit (or promise) to deliver certain aspects of their future policies, the resulting economic outcomes will be better. In their context 'credible' refers to the public's believing that the policymakers will keep their promises, even if they face incentives not to.

As Kydland and Prescott (1977) illustrate, it is advantageous for policymakers to publicly commit to policies for low inflation. When policymakers' statements are believed, the public will expect inflation to be low and demands for wage and price increases should accordingly be moderate. Such behaviour by the public renders the central bank's commitment to low inflation easier to fulfil. On the contrary, if the public does not believe the central bank's commitment to low inflation, then its expectations will be higher than otherwise. High inflation expectations result in more aggressive wage and price demands, which make it more difficult and costly for the central bank to achieve and maintain low inflation.

[56] Similar points to those in Kydland and Prescott (1977) can also be found in Calvo (1978). Yet, Barro and Gordon (1983a) extension of the "inflation bias" concept in the style of Kydland and Prescott (1977) proved highly influential.

However, the critical issue that Kydland and Prescott (1977) did not address was how, actually, a central bank is supposed to obtain credibility in the first place. An attempt of an elaborate answer was provided by Rogoff (1985) who demonstrated analytically why even a President who is not particularly averse to inflation (not more than the general public on average), might find it advantageous to appoint a well-known "inflation hawk" as chairman of the central bank. Such an appointment will increase the inflation-fighting credibility of the central bank, which in turn will enable the achievement of low inflation at a smaller cost.

However, as in Rogoff (1985), just to appoint such a director for the central bank may not suffice to guarantee credibility for monetary policy as it is also necessary for the central bank to be perceived by the public as being sufficiently independent from the rest of the government in order not to be affected by short-term political pressures. Therefore, the idea proposed was for both the appointment of central bankers that are averse to inflation and of measures warranting central bank independence, which were proven to be highly influential while supported by a huge amount of empirical work[57]. The credibility benefits of central bank independence have been widely recognized in the past and, in fact, shaped the design of central banking institutions[58].

[57] Walsh (2000, Section 8.5) provides a review of the relevant empirical research on the issue. A consistent result is that more independent central banks produce lower inflation without an increase in output volatility.

[58] Bernanke (2005) claims that "the benefits of central bank independence should not lead us to ignore its downside, which is that the very distance from the political process that increases the central bank's policy credibility by necessity also risks isolating the central bank and making it less democratically accountable", necessitating, thus, "communication with the public and their elected representatives". In addition, "central bank independence does not imply that central banks should never coordinate with other parts of the government, under the appropriate circumstances" (Bernanke (2005), p. 279).

Yet, the solution to the central banks' credibility problems as proposed in Rogoff (1985) does come with certain limitations. First, even though enhanced credibility for monetary policy and lower inflation on average may be achieved by an inflation-averse central banker, he might refrain from responding in a socially desirable way to various shocks hitting the economy[59].

Second, in practice, the policy preferences of a newly appointed central banker will be inferred by the public from policy actions. Realising that the public makes such inferences, the central banker may be tempted to misrepresent the state of the economy (see Canzoneri (1985)) or even to undertake policy actions that are suboptimal. He may, for example, feel compelled to tighten policy more aggressively so as to give proof of his determination to fight inflation. The necessity of such inferences by the public may even lead to economic instability, a proposition that is debated in the recent literature on the macroeconomic consequences of learning[60].

The above issues were addressed by Walsh (1995) who puts forward the idea that the government or society could offer the head of the central bank a performance contract[61], which would include explicit monetary rewards or penalties depending on the economic outcomes occurring with respect to his policy. Walsh (1995)

[59] When, for example, an inflation-averse central banker faces an aggregate supply shock (e.g. a sharp rise in oil prices) will tend to react in an over-aggressive manner so as to offset the inflationary impact of the shock, paying less attention on the effect such policy may have on output and employment. Lohmann (1992) proposes a solution to the above as the government's limiting the central bank's independence by intervening at times when the supply shock becomes too large. Yet, it is vital, in this case, to clearly state in advance the circumstances under which the government is going to intervene, so that the central bank's independence can be ensured. Such statements, though, may not be practical enough to deliver.

[60] A, now, standard reference on learning in macroeconomics is Evans and Honkopohja (2001). See also, for example, Erceg and Levin (2001) and Orphanides and Williams (2005) for applications of models of learning to US monetary policy analysis.

[61] For an influential analysis of the contracting approach see also Persson and Tabellini (1993)

demonstrated that, in principle, a contract between the government and the central bank that may be rather simple, would lead to the implementation of both credible and fully optimal monetary policies.

The contract permits the government to give the central banker a basic level of compensation and, then, to impose a penalty depending on the realized rate of inflation, namely the higher is the observed inflation rate, the greater the penalty will be. The contract would guarantee credibility, if the penalty imposed for inflation is large enough to affect central bank behaviour and if the public, actually, understands the nature of the contract[62]. What is common in both Rogoff (1985) and Walsh (1995) is that when the central banks face imperfect credibility it is beneficial to assign to the central banker an objective function that differs from the true objectives of the society. Walsh (1995), however, also shows that binding central bankers with an optimal contract ameliorates the two problems with respect to Rogoff's (1985) approach. This is so since, first, there are incentives for the central banker to achieve the target for inflation and respond to supply shock in a socially optimal way[63], and, second, because the public can clearly infer the central banker's preferences from the actual contract.

In practice, one cannot find many incentive contracts for central bankers. The most famous one is a plan that had been proposed to the New Zealand legislature, which

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[62] Bernanke (2005) refutes an objection to this point by stressing that "although the central bank's incentives are made clear by the contract, the public might worry that the government might renege on its commitment to low inflation by changing the contract. Those who discount this concern argue that changing the contract in midstream would be costly for the government, because laws once enacted are difficult to modify and because changing an established framework for policy in an opportunistic way would be politically embarrassing" (Bernanke (2005), p. 280).

[63] The assumption that gives rise to this result is that the central banker cares both about the state of the economy and the income yielded with respect to his incentive contract.

yet was never adopted, that included clauses for firing the governor of the central bank if the inflation rate deviated too far from the government's inflation objective, as pointed out by Bernanke (2005). But, as Bernanke (2005) asserts, incentive contracts as in Walsh (1995) best represent a metaphor rather than as an actual proposal. Even though the pay of central bankers may not depend directly on the realized rate of inflation, they tend to be affected by several other aspects of their jobs, like "their professional reputations, the prestige of the institutions in which they serve, and the probability that they will be reappointed"[64] (Bernanke (2005), p. 278-280). An additional practical issue of importance is accountability to the public as well as to the government, in that the central bank should explain regularly what it is trying to achieve and for what reasons. The papers mentioned above and the several subsequent ones provide the theoretical foundation supporting an explicit, well-designed, and transparent framework for monetary policy, which states the objectives of policy and holds central bankers accountable for reaching those objectives (or even for giving a detailed explanation of why those objectives were not reached)[65] (Bernanke (2005), p. 281).

[64] The analysis that originates in Walsh (1995) suggests that central bank performance might be improved if the government set standards for performance (as part of the institution's charter or enabling legislation) and, consequently, regularly compared objectives and outcomes. Alternatively, macroeconomic goals might be set through a joint exercise of the government and the central bank since central banks tend to possess greater expertise in determining which economic outcomes are both feasible and most desirable. Several countries have, for example, established inflation targets and central bankers in those countries evidently make strong efforts to attain those targets. As is also reported in Bernanke (2005), even though "the Federal Reserve Act does not set quantitative goals for the U.S. central bank, it does specify the objectives of price stability and maximum sustainable employment and requires the central bank to present semi-annual reports to the Congress on monetary policy and the state of the economy" (Bernanke (2005), p. 280).

[65] Of course, other factors that cannot be covered in this review, such as the central bank's reputation for veracity as established over time, may also strengthen its credibility (Barro and Gordon (1983b), Backus and Driffill (1985)). But see Rogoff (1987) for a critique of models of central bank reputation (Bernanke (2005), p. 281).

The efforts to tame inflation in the late seventies and the early eighties, the disinflation episodes, for example, in the US, the UK, Canada and other countries affected to a great extent the direction of monetary theory and policy towards assessing the benefits of central bank credibility and addressing the ways it can be obtained. During almost the past two decades, this new thinking stirred a great number of changes in central banking, in particular concerning the institutional design of central banks and the establishment of new frameworks in the conduct of monetary policy.

For example, Taylor (1996), Fischer (1996) and Svensson (1996), King (1996) in Federal Bank of Kansas City (1996), all discuss inflation targeting with reference to a utility function of the form incorporating the two objectives of price and output-gap stabilisation. As shown in Svensson (1997a) and Ball (1997), concern about output-gap stability translates into a more gradualist policy. Thus, if inflation moves away from the inflation target, it is brought back to target more gradually. Equivalently, inflation-targeting central banks lengthen their horizon and aim at meeting the inflation target further in the future (Svensson, (2001), p. 65).

Considering the conduct of monetary policy under the prominent trend of inflation targeting, Blinder (2005) argues about the type of instrument the central bank should use in order to pursue its inflation target. He remarks that “no matter how much theoretical models try to pretend that it is, the inflation rate is not a control variable. Milton Friedman taught that the nominal interest rate is a bad choice; fixing it can even lead to dynamic instability. The real interest rate, we have learned in the Volcker and Greenspan years, is a far better choice” (Blinder (2005), p. 284).

Greenspan, in particular, has focused attention on an update of Wicksell's "natural interest rate" concept[66] and, as Blinder (2005) remarks, more by his actions than by his rhetoric, he has called attention to the Taylor rule as a useful benchmark. The following gives the Taylor rule, in a simple form, as a guide for setting the nominal funds rate in a way that stabilizes both inflation and output, is the following:

$$i = r^* + \pi + \alpha\left(\pi - \pi^*\right) + \beta\left(y - y^*\right),$$

where $i$ is the nominal funds rate, $r^*$ is the neutral level of the real funds rate, $\pi$ is the inflation rate, $y$ is the (log) of output, and $\pi^*$ and $y^*$ are the targets for inflation and output, respectively. In this way, one can think of monetary policy as "easy" when $i < r^* + \pi$ and as "tight" when $i > r^* + \pi$. It is worth mentioning that the Taylor rule, proposed in Taylor (1993), was never intended to be a literal rule in the sense the Friedman proposed. Nonetheless, it constitutes a very useful way of thinking about monetary policy.

Blinder (2005) applies focus on two aspects of the Taylor rule. The first is that both $\alpha$ and $\beta$ are positive, implying that, for example, at times the central bank may find it appropriate to hold its interest rate below neutral even though the inflation rate is above target[67]. The other aspect is that $\alpha$ is positive meaning that the central bank should react to changes in the rate of inflation more than point for point. For example, for a choice of $\alpha$ equal to 1/2, each one-point move in the inflation rate would induce the central bank to adjust its policy rate by 150 basis points in the same

[66] Woodford (2003), (pp. 21, 49-55) provides an analysis on Wicksell's notion of the natural real rate of interest, i.e. the rate of interest required for equilibrium with stable prices. It is also referred in the literature as the neutral or the equilibrium real rate of interest.

[67] Or, if $y$ is high enough, and even if inflation is below target, the central bank will still want "tight money".

direction, implying, thus, that the real funds rate will move by 50 basis points in that direction. For $\alpha$ not being positive, the central bank would be allowing rising inflation to reduce the real federal funds rate, which is a potentially destabilizing policy (Blinder (2005), p. 285).

Blinder (2005) admits that a lesson drawn from the Greenspan era that tends to be hardly ever mentioned is that “three times during the Greenspan era, the Fed demonstrated that doing nothing can constitute a remarkably effective, even bold, monetary policy” (Blinder (2005), p. 285). He comments, further, that if the central bank communicates its future policy direction with the markets, then the latter can do part of the work of monetary policy. In fact, if the markets believe that the central bank is about to raise (or lower) rates, then the intermediate and long-term rates will tend to rise (or fall), thereby tightening (easing) “monetary policy” before the central bank actually takes action. Letting, in this way, the bond market do part of the ‘work’ for the central bank has according to Blinder (2005) two interesting, and probably valuable, implications for monetary policy. These are that, “first, and less important, the central bank should not have to move its policy rate around as much, in either direction, as would be necessary without the anticipatory behaviour of the bond market, and, second, and more important, the lags in monetary policy should be reduced by the bond market’s reactions” (Blinder (2005), p. 286). He, further, notes that “not so many years ago, central bankers and economists viewed long rates as following short rates with a substantial lag – which slowed down the transmission of monetary policy impulses into the real economy,… [while] nowadays, many central bankers and economists see long rates as leading short rates” (Blinder (2005), p. 286). This anticipatory process, however, can only work if the central bank effectively communicates its intentions to the markets[68]. Thus, greater transparency can enhance the effectiveness of monetary policy, since transparency can influence the public's expectations, which play an important role in the transmission mechanism of monetary policy. Greater transparency may make monetary policy more efficient, help to build a monetary authority's credibility, and reduces the inflation bias (Moessner, Gravelle and Sinclair (2005), p. 286). The old tradition at central banks has been to say little. Admittedly, according to Blinder (2005) "there is still far too much secrecy". Nevertheless, the unmistakable trend for central banks around the world is the call for greater transparency (Blinder (2005), p. 286).

### 3.4 The 'Benchmark' Model

The prevailing model of the transmission mechanism of monetary policy incorporates the effect of monetary policy actions on short-term interest rates (and the exchange rate), that, consequently, affect the evolution of the output gap and inflation expectations, which in turn determine inflation. In essence, in a closed economy setting, the model contains an IS relationship between monetary conditions and the output gap, and a Phillips curve relating the output gap and inflation expectations to future changes in the rate of inflation. The above paradigm in combination to a formal representation of the optimal choice of a policy rate from the

[68] See also Moessner, Gravelle and Sinclair (2005) that summarises the relevance of transparency for the monetary policy transmission mechanism, and presents a measure for quantifying differences in the transparency for monetary policy using financial and economic data. Their approach consists of studying the reaction of market interest rates to official interest rates decisions and surprises in macroeconomic data and news.

part of the central bank, either in the form of a simplified or an optimally derived rule, can demonstrate the dynamic adjustment paths to a steady state.

Clarida, Gali and Gertler (1999), for example, analyse the optimal policy problem in two stages. In the first stage, they determine the optimal path of inflation and the output gap and, in the second stage, they work out the policy rate path, compatible with the optimal solution, determined in stage one, using a forward-looking IS curve. The resulting framework indicates how interest rates, inflation, and real output are jointly determined in a model that does not allow for endogenous variations in the capital stock, assumes perfectly flexible wages (or some other mechanism for efficient labour contracting), and also monopolistic competition in the goods markets where prices are sticky and are adjusted at random intervals in the process as in Calvo (1983) (Woodford (2003), p. 239).

In particular, the model is a dynamic general equilibrium model that, first, presumes that the goods market is populated with a set of monopolistically competitive firms as in Dixit and Stiglitz (1977). Second, this imperfect competition means that firms must set prices. As in Calvo (1983), firms commit to a fixed nominal price in advance of knowing the demand for that period. At the end of each period a fraction of the firms are allowed to adjust their price freely, while the remaining firms increase theirs' based on the inflation rate observed in the period[69]. This so-called

[69] Several variations have been proposed in the way in which the rigidities are modelled. These variations have very different implications for the dynamic effects of nominal shocks on real variables. The difference in the modelling strategies is based on differences in the timing of price or wage change decisions. Three basic propositions are used, which are based on Fisher (1977), Taylor (1980) and Calvo (1983). Each one gives rise to very different dynamic responses of real variables to nominal shocks. Fischer (1977), for instance, takes prices as predetermined, implying that at some time agents set prices for some number of future periods. In this case, the price-level that is set on the decision date may differ for the different periods before the next decision date. The impact of a nominal shock, in this model, lasts for only as long as it takes for all price setters to have a chance to

partial indexation assumption is made so that the model's predicted persistence in inflation will match that found in the data. Third, firms produce using labour under a marginal diminishing returns technology. Fourth, output is demand determined at the set price. Finally, the model allows for shocks that create a tension between price stability and output gap stabilization. For example, in the case of a positive "cost-push" shock inflation rises and output falls relative to its natural level (Gaspar and Kashyap (2006), p. 96).

Inflation in this framework is inefficient because firms have promised to meet demand at their fixed nominal price. Consequently aggregate inflation moves real, relative prices (which is inefficient). The model's presumption of nominal price rigidity is appropriate since absent some sort of price stickiness monetary policy will be neutral; if prices can all adjust proportionally following a change in the quantity of money then no real quantities (including most importantly the real interest rate) will be affected by monetary policy (Gaspar and Kashyap (2006), p. 96). The source of the nominal rigidity that allows monetary policy to alter short-run real rates of return has been under debate for decades. Christiano, Eichenbaum and Evans (1997) give a comprehensive summary of this discussion, distinguishing three sets of theories: one based on sticky wages, the second on sticky prices and the third formed with respect to the notion of limited participation. The first two kinds of models built

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reset their price schedules. Taylor (1980) models prices or wages as fixed, implying that their nominal value does not vary between decision dates. Under fixed prices or wages, nominal shocks die out only asymptotically. In Calvo's (1983) model, which is still widely used in the extant literature, price-setters alter their prices according to a Poisson process, which leads to a variety of possible dynamics, (Cecchetti (2001), p. 191). One attractive aspect of Calvo's model is that it shows how the coefficient on output in the inflation equation will depend on the frequency with which prices are adjusted. A fall in the constant probability that the firm will be able to adjust its price, which means that the average time between price changes for an individual firm increases, causes the coefficient on output to decrease. Output movements have a smaller impact on current inflation, holding expected future inflation constant. Because opportunities to adjust prices occur less often, current demand conditions are less important (Walsh (2000), p. 220).

on the idea that nominal price and wage changes are effected with several costs, rendering adjustments rather infrequent. According to the limited participation models that have been introduced by Rotemberg (1984), households are unable to adjust their cash balances sufficiently rapidly as a response to changes in the environment; meaning that they have a ‘limited’ ability to ‘participate’ in the financial markets, and therefore have to restrict themselves to certain portfolio holdings for relatively long periods of time (Cecchetti (2001), p. 174-175).

As is shown in Woodford (2003), under rational expectations, the standard assumptions lead to a Phillips curve of the form

$$(1)\ \pi_t - \gamma\pi_{t-1} = \beta\left(\mathrm{E}_t\pi_{t+1} - \gamma\pi_t\right) + \kappa\left(y_t - y_t^*\right) + u_{t,}\,,$$

where $\pi$ is inflation, $\left(y_t - y_t^*\right)$ is the output gap, $\beta$ is the discount rate, $\kappa$ is a convolution of the structural parameters, $\gamma$ is the degree of indexation of prices, not optimally set each period, and $u$ is a cost-push shock (assumed i.i.d.). Thus, in equation (1) inflation is determined by lagged inflation, inflation expectations, the output gap and the shock.

Clarida, Gali and Gertler (1999) show the IS equation of the following form:

$$(2)\ \left(y_t - y_t^*\right) = E_t\left(y_{t+1} - y_{t+1}^*\right) - \alpha\left(i_t - E_t\pi_{t+1}\right) + v_t\,,$$

which is obtained by log-linearizing the consumption Euler equation that arises from the household’s optimal saving decision, after imposing the equilibrium condition that consumption equals output minus government spending. It is stressed that the main feature is that higher expected future output is shown to raise current output.

The reason behind this is that individuals prefer to smooth consumption and the expectation of higher consumption next period (in association to higher expected output) leads them to want to consume more today, which, in turn, increases current output demand. The negative effect that the real rate imposes on current output reflects intertemporal substitution of consumption. In this respect, the interest elasticity, $\alpha$, corresponds to the intertemporal elasticity of substitution (Clarida et al. (1999), pp. 1665-66).

Furthermore, up to a second order approximation, the (negative of the) period social welfare function (as also shown in Woodford (2003)) takes the form

$$(3)\quad L_t = \left(\pi_t - \gamma\pi_{t-1}\right)^2 + \lambda\left(y_t - y_t^*\right)^2$$

where $\lambda$ is a function of the underlying structural parameters. The problem of minimizing the loss function in equation (3) subject to the linear constraint (1), given by the New Keynesian Phillips curve resembles the classic linear quadratic framework explored in the 1950s by Simon (1956) and Theil (1954, 1957). Simon and Theil extended the deterministic framework of Tinbergen (1952) to a stochastic set-up and showed that, in the linear-quadratic framework, both certainty equivalence and the separation of estimation and control held true. The main difference of our problem relative to the classical policy instrument choice framework is that expectations about the future are endogenous and influence the current state of the economy. Recently, Svensson and Woodford (2003) have identified conditions for these results to hold in models with forward-looking behaviour (Gaspar and Kashyap (2006), p. 97).

Carlin and Soskice (2005) present a novel graphical approach of a simple version of the above model that demonstrates the forecasting exercise of a central bank and the adjustment of the economy to the new equilibrium as the optimal monetary policy is implemented. The model is not “forward looking”, i.e. does not incorporate equations that include expectations of future values of endogenous variables, and consists of a central bank loss function, an *IS* equation and a Phillips equation taking into account a one period lag on the effect of the real rate to output (*IS* equation) and demonstrating inflation inertia, namely that the current level of inflation is a function of lagged inflation and the output gap (Phillips equation).

In a two-period case with periods numbered zero and one, their model takes the following form:

$$L = \left(y_1 - y_e\right)^2 + \beta\left(\pi_1 - \pi^T\right)^2, \qquad \text{(Central Bank Loss Function)}$$

$$\pi_1 = \pi_0 + \alpha\left(y_1 - y_e\right), \qquad \text{(Phillips Curve)}$$

$$y_1 - y_e = -a\left(r_0 - r_S\right), \qquad \text{(}IS\text{ equation)}$$

Where $y_1$ is the level of output in period one, $y_e$ is equilibrium output, $\pi_0$ and $\pi_1$ the level of inflation in periods zero and one respectively, $\pi^T$ the inflation target set by the central bank, $r_0$ the real short rate and $r_S$ the stabilising rate. The central bank can set the nominal short term interest rate directly, and since implicitly at least the expected rate of inflation is given in the short run, the central bank is assumed to be able to affect the real interest rate indirectly – as is postulated by the Fisher identity (Carlin and Soskice (2005), pp. 14-16).

The interest rate rule is derived optimally from the minimisation of the central bank's loss function subject to the Phillips curve. The resulting equation, which they term as the *MR-AD* equation (standing for monetary rule – aggregate demand equation), shows how output (chosen by the central bank through its interest rate decision) should respond to inflation. Consequently, by substituting for the output gap using the *IS* equation they derive the interest rate rule, the *IR* equation, which takes the following form:

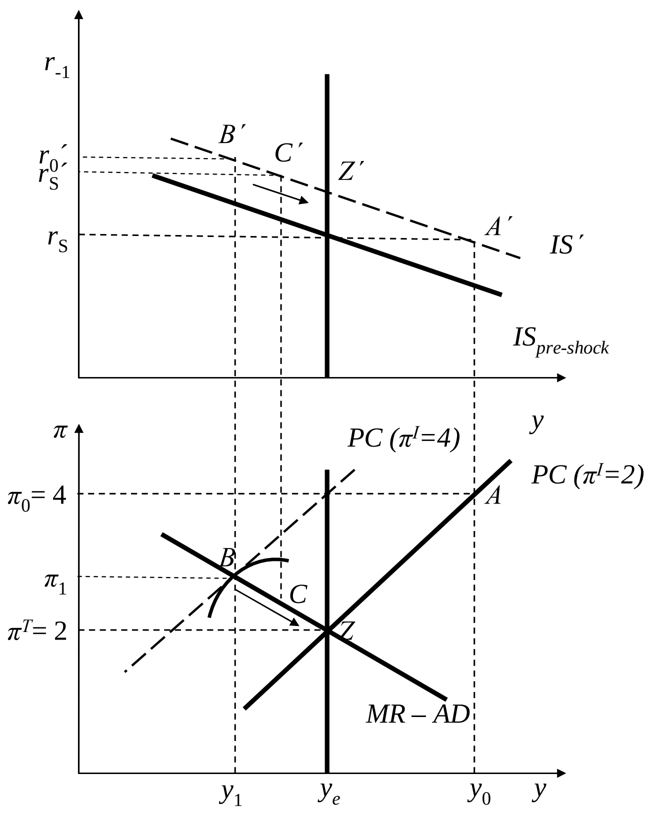
$$\left(r_0 - r_S\right) = \frac{\alpha\beta}{a\left(1+\alpha^2\beta\right)}\left(\pi_0 - \pi^T\right), \qquad \text{(}IR\text{ equation),}$$

For $a = \alpha = \beta = 1$, $\quad \left(r_0 - r_S\right) = 0.5\left(\pi_0 - \pi^T\right)$.

Their diagrammatic representation of the *IS* equation, the Phillips curve and the *MR-AD* equation, showing the adjustment to equilibrium after an *IS* shock is as follows: The lower diagram depicts, first, the long-run Phillips curve, as a vertical line in $y_e$, the level of equilibrium output, namely the level at which price and wage setters, in imperfect labour and product markets, will make no attempt to change the prevailing real wage or relative prices. The economy is in a constant inflation equilibrium at the output level $y_e$ and for the target level of inflation $\pi^T$ = 2%, point *Z*. The real interest rate required to produce a level of aggregate demand equal to the equilibrium output is the stabilising rate, $r_S$, shown in the upper diagram, the *IS* diagram[70]. The short run Phillips curves are indexed by the inertial rate of inflation (labelled $\pi^I = \pi_{-1}$).

[70] The vertical axis in the *IS* diagram is labelled $r_{-1}$ to depict the one-period lag on the effect from the real interest rate to output.

*Figure 3.1: How the central bank decides on the interest rate*



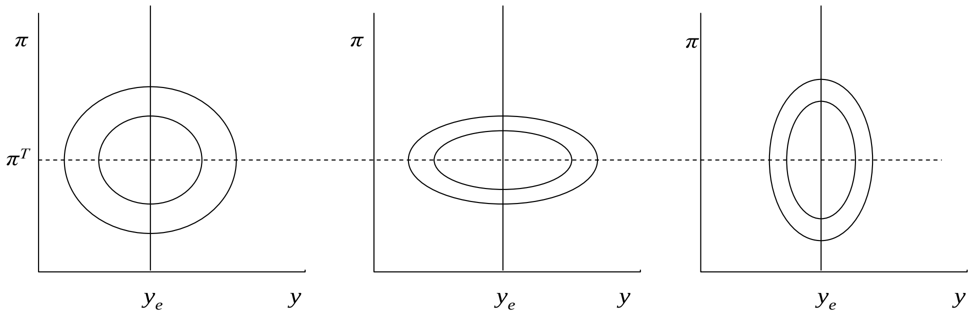

Source: Carlin and Soskice (2005), p. 19.

An aggregate demand shock shifts the *IS* curve to *IS´* and the economy is at point *A* in the Phillips diagram. In response to the new information, the central bank needs to make a forecast of the Phillips curve next period in order to set its policy rate. The tangency point, *B*, of the forecast Phillips curve $\left(PC\left(\pi^I = 4\right)\right)$ with the relevant[71] central bank indifference curve define the desired level of output for period one, $y_1$. The *MR - AD* line joins point *B* with *Z*. The next step is for the central bank to

[71] See Figure 3 for a representation of the central bank's indifference curves. It depicts the indifference curves drawn for the central bank's two-period loss function for different levels of $\beta$, i.e different degrees of inflation aversion. The loss declines as the graph gets smaller and when it shrinks at a single point (namely point $\left(\pi^T, y_e\right)$) the loss is zero.

forecast the *IS* curve for period one in order to set the interest rate corresponding to the desired level of output, $y_1$, (Carlin and Soskice, (2005), p. 18). After the shock both inflation and output have been reduced and through a similar process the economy is led back to equilibrium.

***Figure 3.2: Central bank loss function: varying the degree of inflation aversion***




(a) Balanced: $\beta = 1$ (b) Inflation averse: $\beta > 1$ (c) Unemployment averse: $\beta < 1$

Source: Carlin and Soskice (2005), p. 35.

### 3.5 Concluding Remarks

The ‘benchmark model’ (and the broad set of extensions) suggests a set of major conclusions about the role of monetary policy. A set of four main conclusions are emphasised by Goodfriend and King (1997): (1) “monetary policy actions can have an important effect on real economic activity, persisting over several years[72], due to gradual adjustment of individual prices and the general price level[73]. (2) Even in settings with costly price adjustment, the models suggest little long-run trade-off between inflation and real activity. (3) The models suggest significant gains from eliminating inflation, which stem from increased transactions efficiency and reduced relative price distortions[74]. (4) The models imply that credibility plays an important role in understanding the effects of monetary policy (Goodfriend and King (1997), p. 232). They find these issues to be consistent with monetary policymakers' statements in several countries.

In addition it is worth pointing that Clarida, Gali and Gertler (1999) distinguish that the policy rules proposed in the extant literature do in fact provide for the events of financial crises. A frequently cited reason that they recognise on why monetary policy should not adhere tightly to a simple rule is the need for flexibility in the event of a financial collapse. Following the U.S. stock market crash in October 1987, for example, the decision of the Federal Reserve Board to reduce interest rates gained firm support, which was based largely on instinct as there had been virtually no formal theoretical work to rationalise his kind of intervention. They finally contend that "concern about financial stability appears to be an important constraint on policy-making, and it is, in fact, one possible reason why central banks smooth interest rate changes" (Clarida, Gali and Gertler (1999), p. 1703).

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[72] This major lagged effect has been accepted to span over 18 to 24 months.

[73] This effect has been modelled in various ways with respect to the time-lags in the variables entering the IS and the price-setting function, i.e. respectively the time-lags from the interest rate to output and from output to inflation.

[74] Goodfriend and King (1997, 2001) assert that nominal price stickiness is the only distortion preventing the identity between the rational expectations equilibrium and the first best allocation of resources, and therefore, the optimal monetary policy aims at reproducing the allocation of resources which would occur under flexible price equilibrium.

The model ignores the monetary and financial analysis that plays an important role in a central bank's decision-making, as Gaspar and Kashyap (2006) point. A clear demonstration of this omission[75] is Chart 2.1. showing the monetary transmission mechanism (presented in Chapter 2). The logic of the New Keynesian model can be traced through the left hand side of the Chart 2.1, which shows the link between the official interest rate, expectations and prices. The chart, however, also shows that policy is believed to operate by affecting bank and market rates, which are thought to influence prices independently. In Woodford (2003, chapter 4) this connection is precisely derived. In particular, he shows that the IS function can be of the following form:

$$\left(y_t - y_t^*\right) = \eta E_t\left(y_{t+1} - y_{t+1}^*\right) + \alpha\left(\rho_t - E_t\pi_{t+1}\right) + v_t \ ,$$

where $\rho$ is the interest rate that is relevant for spending decisions and $v$ is the aggregate demand shock. One of the points of Woodford (2003) is that the above equation is consistent with Wicksell's view of the economy. Gaspar and Kashyap (2006) assert that though Wicksell himself presumed that a "loan" rate was the relevant one for spending, $\rho$ can be refered to as a loan rate, while it could also be interpreted as the required return on equity or the corporate bond rate. In contrast to the Wicksellian approach, the convention in the recent literature is to equate $\rho$ with the policy rate (Gaspar and Kashyap (2006), p. 102). They believe that the distinction between treating $\rho$ as being perfectly and imperfectly linked to the policy rate is critical. One reason provided for considering an imperfect connection is that no users of this model believe that the short-term interest rate is the critical interest rate for

[75] In their analysis, such a conclusion is reached with respect to the ECB, yet it applies to a general extent.

spending. Instead one presumably equates $\rho$ with the policy rate because the appropriate longer term interest rate that belongs in the above equation is itself a stable function of the policy rate. The expectations hypothesis of term-structure determination might justify this simplification if there were no time-variation in any term-premia. However, Cochrane and Piazzesi (2005) (among others) document the considerable time-variation in term-premia. More importantly, the Fall 1998 and September 2001 episodes specifically suggest that policymakers are sometimes quite concerned about such variation (Gaspar and Kashyap (2006), p. 106).

Therefore, while it is deemed crucial for the monetary authorities to monitor developments regarding the connections between the policy rate and market rates (and asset prices), the consensus model (and proposed extensions), to our knowledge, fails to provide a widely accepted structural representation of the monetary and financial system and of their role in the transmission mechanism of monetary policy.

# PART TWO

# CENTRAL BANKS FACING ASSET PRICE BUBBLES:

# A CRITICAL REVIEW

# CHAPTER 4

# FINANCIAL STABILITY AND CENTRAL BANK OBJECTIVES

## 4.1 Introduction

Since financial institutions are the issuers of the largest component of the money stock, from the beginning of their formation central banks have had a natural interest in maintaining financial stability. The stability of the financial system, in turn, promotes the smooth functioning of the payment systems and the effective transmission of monetary policy, thus, ensuring that the primary monetary policy objective of achieving and maintaining price stability is reached. Furthermore, a robust financial system enhances the resilience of the economy to shocks of various sources, having also an effect to the overall performance of the economy.

A definition of the rather complex notion of financial stability has been considerably demanding, and eventually seen by most analysts as a ‘negative’ concept, namely in terms of avoiding financial crises. Financial stability, however, has a positive dimension, as “it is a condition where the financial system is capable of performing well at all of its normal tasks and where it is expected to do so for the foreseeable future… requiring that the principal components of the system – i.e. financial institutions, markets and infrastructures – are jointly capable of absorbing adverse disturbances. [Financial stability] requires that the financial system is facilitating a smooth and efficient reallocation of financial resources from savers to investors, that financial risk is being assessed and priced accurately and that risks are being efficiently managed" (ECB (2004a), p. 7). There is also a forward-looking dimension to the stability of the financial system as the inefficient allocation of capital and the mispricing of risk may render the system fragile enough to guarantee stability in the future and avoid wide-scale contagious effects to the economy as a whole.

As Sinclair (2001) points out "without trying to understand such phenomena of risks and crises, whenever and wherever they occur, we have little hope of preventing their repetition"[76] (Sinclair (2001), p. 1). Consequently, when assessing the stability of the financial system in order to determine the necessity of undertaking remedial action or not, the regulatory and monetary policy authorities can follow three broad steps as identified by ECB (2004a): "The first entails forming an assessment of the individual and collective robustness of the institutions, markets and infrastructures that make up the financial system. The second involves an identification of the main sources of risk and vulnerability that could pose challenges for financial system stability in the future. The third and final step is an appraisal of the ability of the financial system to cope with crisis, should these risks materialise" (ECB (2004a), p. 7). As the process of design and conduct of monetary policy incorporates the effects of main sources of risk and vulnerability to the financial system, the above refers to addressing sources of negative outcomes that tend to be considered as considerably unlikely, but possible to cause highly adverse impacts to the financial system and the economy overall.

[76] For an analytical discussion refer to the twelve questions about financial stability presented in Sinclair (2001), p.7- 8 and the pertinent debate in Healey and Sinclair eds. (2001).

## 4.2 Public Policy and Financial Stability

A liberalised financial system is more apt to accommodate fluctuations in economic activity and even to reinforce them. In particular, in such a system, the participants' varied perceptions of value and the willingness to undertake risk are vital factors driving economic activity, which are closely related to business conditions, stirring the potential of amplifying fluctuations in economic activity. From this viewpoint, credit, asset prices and indicators of the pricing of risk (as for example credit spreads) are justified as highly procyclical. Booms in economic activity may also give rise to self-reinforcing processes encompassing rises in asset prices, laxity in the constraints to external financing, possibly currency appreciations, further capital deepening, a rise in productivity and increase in measured profits. The reverse will take place during contractions. Even though the above processes are a natural part of business fluctuations, at times their intensity may be of such a high degree that the financial system's inherent stabilisers may fail to protect it from becoming overstretched. Crockett (2003), among others, advocates that 'financial imbalances' and their associated distortions in the real economy would build up under a facade of benign economic conditions. When these imbalances eventually unwind, the effects can be acutely adverse, causing serious strains on the economy or in the worst case serious financial instability (Crockett (2003) p. 3).

In general, the concept of financial stability typically refers to preserving the core economic functions of the financial system in order to enhance the unobstructed channelling of savings into investments and provide for an efficient and safe payment mechanism. Along these lines, Padoa-Schioppa (2002) suggests defining financial stability as “a condition where the financial system is able to withstand shocks without giving way to cumulative processes which impair the allocations of savings to investment opportunities and the processing of payments in the economy. In the jargon of central banking, this function used to be labelled as maintaining “orderly conditions” in the financial system” (Padoa-Schioppa (2002), p. 20).

Safeguarding financial stability never failed to be a principal and fundamental concern of central banks. In this sense, a financial stability objective for central banks would be fitting. However, it would seem difficult to decide on the weight applied to the financial stability objective in comparison to the other objectives. In addition, it may prove considerably demanding to judge the degree of ‘activism’ exercised by a central bank while in pursuit of their financial stability objective.

An additional crucial issue is an accurate and useful definition of financial stability. Most efforts have been made by addressing the issue as a ‘negative concept’ and defining, thus, financial instability, which according to Sinclair (2007) means that “none of our banks is in or near the brink of insolvency, and our currency is not lurching, or thought to be about to lurch, in extreme value” (Sinclair (2007), p. 2). Ferguson (2003), also, views a useful for a central bank concept of financial instability to involve some notion of market failure or externalities that may potentially influence real economic activity (Ferguson (2003), p. 7). The presence of market imperfections such as moral hazard and asymmetric information that can be widespread and of a significant level may pose a substantial threat to the functioning of an otherwise healthy financial system. The (isolated or combined) outcomes that may be in the form of bank runs, panics, bubbles in asset prices, excessive leverage, or inadequate risk management, reflected in sharp and prolonged shifts of financial prices from their fundamental level, credit conditions that are either too lax at certain periods or far too restrictive at others, as well as greater volatility in spending and real activity, tend to be highly undesirable from a social welfare viewpoint.

By viewing financial instability as above, Ferguson (2003) distinguishes between two roles for public policy in the pursuit of financial stability, conducted by central banks and other authorities: the prevention of instability and the management of the consequences when markets become unstable. Addressing the first, he views that "the single most important thing a central bank can do is to foster a macroeconomic environment of low and stable inflation and sustainable economic growth" (Ferguson (2003), p. 7). If this fails to be the case, the risks of the financial system becoming unstable are higher and the effects of the latter are more harmful. Nevertheless, central banks can and, in fact, have traditionally undertaken various activities in order to attenuate the risks of financial instability, such as impose effective financial regulations, strive for efficient bank supervision, as well as operating or overseeing properly functioning payment systems. Concerning the aspect of managing the consequences of financial instability converting into a crisis, central banks can utilise their basic tools so as to alleviate liquidity pressures and prop up public confidence. They can, for example, provide reserves via open market operations or lend directly to depository institutions through a lender-of-last-resort operation or via the discount window, in addition to possibly cutting reserve requirements or lower the policy rate. Therefore, it is vital from a social welfare perspective that central banks and other authorities strive to encourage and support private sector planning and investments that fully reflect the social value of contingency arrangements (Fergusson (2003), p. 7-8).

Nevertheless, it seems important to note that one should not lose sight of the remarkable efficiency and stability financial markets can at times exhibit. At the arrival of new information, financial asset prices are expected to respond promptly, justifying, thus, the occasional volatility in asset prices. Moreover, financial markets are both dynamic and evolving. The forces of competition, deregulation and globalisation, as well as the use of new technologies render some firms obsolete enough to cope with the evolving and more efficient business models forcing them to cease operation. Therefore, a challenging task for central banks and other authorities is to distinguish between the developments that truly represent market failures that necessitate public intervention, from those that reflect an unavoidable, warranted and benign turbulence in the dynamic market, what is commonly termed ‘a shift in fundamentals’ (Ferguson (2003) p. 8).

### 4.3 Central Banks’ Interest in Financial Stability

The foregoing discussion suggests that financial stability to some degree already is an important objective for central banks, even those that are viewed as concerned only with price stability. The vital issue then becomes the relative weight policymakers should apply to financial stability as an objective when they design their policy, rather than whether it should be part of the central objectives or not. The answer is not definitive neither shrank to a small set of alternatives. As Sinclair (2001) remarks, “financial stability impinges upon monetary policy and reacts to it.

There are therefore powerful arguments for retaining responsibility for both within the central bank" (Sinclair (2001), p. 17).

At one extreme, in a central bank focusing almost entirely on price stability concerns about financial stability arise only in the actual event of a crisis. This is what Svensson (2002), for example, identifies as a strict inflation targeting regime. On the opposite side, a central bank may exhibit extreme sensitivity to signs of financial instability and, consequently, a willingness to conduct policy pre-emptively to counter the adverse effects of potential instability even at times when the near-term outlook for economic activity overall and price stability specifically do not warrant such actions (Ferguson (2003), p. 10-11).

According to Ferguson (2003) there are three central issues referring to the degree of activism that central banks should adopt while in pursuit of a financial stability objective. The first issue is about the ways in which a financial stability objective can influence the central bank incentives and other policy goals. He also views a financial stability objective being accorded too much weight as giving rise, even at the margin, to the possibility of impairing the conduct of monetary policy in achieving macro ends. The second issue refers to the perception of the financial stability objective by investors and the public in general, highlighting, in particular, the possibility of an overly activist monetary policy in the pursuit of a financial stability objective giving rise to moral hazard behaviour. The final issue involves questions about whether a highly activist central bank approach with respect to financial stability may actually result in increasing the volatility of economic variables (Ferguson (2003), p. 11). Therefore, since these points suggest that a highly activist approach with respect to financial stability may prove to be rather problematic, it is of significant importance to determine how a central bank may include financial stability considerations into its policy design. In fact, it is also uncontested how considerably challenging it is for policymakers to determine the relevant policy over an extended horizon as it may demand complicated and difficult judgements concerning the short and long-run effects of alternative policy designs. Nevertheless, from the central bank policymaking perspective, concerns about financial instability are mostly weighed with respect to the effects on expectations about inflation and output.

However, a central bank that is confronted with the prospect of financial instability may at times need to alter its policy to an extent greater than would be necessitated solely by the forecasts for inflation and output. According to Ferguson (2003) such an approach is "perfectly consistent with a central bank that conducts monetary policy using forecasts for key macro variables as its primary guideposts but also considers the risks to the forecasts for those key macro variables, as one might think of this as a process of stress testing by monetary policy decision makers in which they regularly assess not just the likely path of output and inflation in reaching their policy decisions but also the potential for adverse outcomes in light of recent or potential shocks" (Ferguson (2003) p. 13).

Finally, bearing in mind that a generally accepted definition of financial stability has not emerged in the literature, and besides the tendency to define financial instability instead, there exists a clear distinction between definitions that refer to the volatility of directly observable financial variables and those that are based on a system approach. The latter tend to broadly follow Mishkin (1991), which can be adapted according to Issing (2003) to a broad, but intellectually convincing definition of financial stability as “the prevalence of a financial system which is able to ensure in a lasting way, and without major disruptions, an efficient allocation of savings to investment opportunities” (Issing (2003), p. 16). The degree of financial fragility can then be viewed as the proximity of the economy to the break point, exceeding that which would impair the efficient allocation of savings[77] (Issing (2003), p. 16).

## 4.4 Financial Stability and Price Stability

More frequent in theoretical work tend to be definitions of financial stability that are more directly observable (even though less conceptually convincing than the one mentioned above) which refer to situations with asset price stability, the absence of banking crises, and relative to some benchmark for the policy rate, interest rate smoothness. Nevertheless, an appropriate standard for even this style of definitions has not yet emerged.

If a definition of financial stability as interest rate smoothness is used, then following the result in Poole (1970) in the face of aggregate demand shocks there is a trade-off with price stability and, thus, the central bank needs to choose the degree of stabilisation of either interest rates or output and inflation. Therefore, a suitable

[77] As this definition focuses on the resilience of the financial system, it would not give proof of financial instability with each individual bank failure or each large shift in an asset price. Conversely, large asset price volatility that may lead to bank and financial institution failures after the realisation of a strong real or financial shock, may even prove the inherent stability or the self-purifying powers of the system, provided that there is no impairment on the efficient financial intermediation and financing process. Issing (2003), views this definition as having “little practical guidance for any institution trying to maintain or to contribute to the goal of financial stability” (Issing (2003), p. 16).

definition of financial stability is crucial with regard to the trade-off between monetary and financial stability (for a detailed discussion see Issing (2003)).

However, the existence of a trade-off between price and financial stability is not widely accepted, since the conventional view regards inflation as a major cause of financial instability. Inflation renders misperceptions about future return possibilities more likely and it can deteriorate the asymmetric information between lenders and borrowers. As high inflation tends to be related to high inflation volatility, the problems of accurately predicting real returns become worse. Traditionally, the presence of high inflation in addition to a business cycle boom has been thought to give rise to real overinvestment and asset price bubbles. Excess liquidity that is provided by the central bank gives rise to inappropriately lax lending standards. Excessive credit growth (in view of realistic return expectations) tends to be a main factor for the development of financial instability. Therefore, price stability and the focus of monetary policy on such an objective are crucial for the stability of the financial markets (Issing (2003), p. 17).

Proponents of the above, to one extreme, even view price stability as sufficient to guarantee financial stability (Schwartz (1995)), or from a less extreme perspective, they claim that financial stability tends to be promoted by price stability (Bordo and Wheelock (1998)). Issing (2003) finds it difficult to discredit the latter because, in the long run, price stability and financial stability reinforce each other, and also since there is sufficient empirical evidence that many financial crises were caused by major price-level shifts and since, historically, most banking crises occurred during the course of recessions that succeeded periods of high inflation (Issing (2003), p.17). In this way, the approach to monetary policy that considers price stability as the principal objective is also appropriate for the maintenance of a stable financial system. Therefore, the conventional view does not accept the presence of a general trade-off between the achievement of monetary and financial stability.

Nevertheless, an environment of stable prices cannot always deter the build up of financial imbalances. The examples most commonly given are the United States during the 1920s and Japan during the late 1980s, which demonstrate that price stability cannot guarantee financial stability as well. At times, even when the only central bank objective is price stability (as defined over the relevant medium-term horizon), to consider financial imbalances while designing monetary policy may lead to a different stance than fixed-horizon inflation targeting (see footnote 78 for more on this point).

In fact, research has recently indicated that achieving and maintaining low inflation leads to the creation of a "new environment" (as mainly stated in the relevant Bank for International Settlements research papers, see eg. Borio, English and Filardo (2003)), that does not reflect a maintenance of financial stability through the safeguarding of price stability. Views have also been expressed as radical as advocating the reverse of the conventional approach mentioned above[78]. The focus

[78] Issing (2003) identifies initial signs of such a discussion can be found in the Federal Open Market Committee (FOMC) minutes of the 13.11.1996 meeting, a few weeks prior to Chairman Greenspan's famous speech on "irrational exuberance". During this FOMC meeting Governor Lindsay mentioned that he was preoccupied by the thought that central bank's success in controlling inflation could produce an extremely optimistic outlook on the future course of the economy. People's false sense of security could lead to asset valuations which could pose problems for the future. Additional arguments have been proposed since then trying to explain why low and stable inflation can increase the vulnerability of the financial system. The main reasons suggested are that "for quite some time inflationary pressure might not show upon inflation itself, due to (a) low pricing power of firms, (b) positive supply side developments and (c) well anchored low inflation expectations" (Issing (2003), p. 18).

that central banks tend to apply mainly on (consumer) price stability is claimed to be insufficient and the suggestion is to address the perceived financial imbalances directly. Such a direct response can be either in terms of prevention (or in the least control) of the building-up process or the smoothing of the adverse consequences when the imbalances are eventually unfolding. Still accepting that the central banks' ultimate objective should be monetary stability, this "new environment" short-term conflict presents the build-up of financial imbalances as crucial enough, even constituting a potential, long-run threat to price stability (Issing (2003), p. 19).

A necessary condition for any central bank intervention is the ability of the central bank to identify in real time the presence of a bubble in asset prices. Varied evidence, though, demonstrates that the developments in the (US for example) stock market during the late 1990s were not related to fundamentals to a great extent. This kind of information is available both to the central banks, as well as the market participants, but as the actual timing of the bursting of the bubble is highly uncertain and extremely difficult to predict, market participants tend to find it more rewarding to exploit the upward trend of the bubble than to bet against it. Issing (2003) finds this view in line with the literature on market efficiency, "which finds that returns are to some degree predictable, but the horizon over which this would be exploitable is too long to be sustainable for individual market participants and, thus the central bank might have a role to play in providing a noisy but unbiased opinion about equilibrium prices to the public" (Issing (2003), p. 19).

If the financial market participants expect the central bank to support the stock market if it crashes, then relevant prices will most likely be increased, helping, thus, the excessive valuation of assets and inflating a bubble that may crash later. Certainly such a series of outcomes is what the central bank would rather avoid. The question raised is whether central bank should try to prick an asset price bubble in the effort to avoid the eventual collapse of the pertinent asset prices, which tends to be highly damaging to the economy. Ceccheti, Genberg, Lipsky and Wadhwani (2000), for example, give an affirmative answer, yet Mishkin and White (2003) find serious flaws in the above argument. Their principal claim is that it is very hard for central banks to determine with precision if a bubble is actually underway. This implies that the monetary authorities have no informational advantage over the private sector. Therefore, if the monetary authorities know of the development of a bubble that will eventually crash, then market participants must be aware of that as well, positioning themselves accordingly restricting the growth of the bubble. If the central bank has no informational advantage then it may well falsely predict the presence of a bubble (as the market may as well), pursuing, thus, the wrong monetary policy (Mishkin and White (2003), p. 76).

By examining 15 episodes of stock market crashes in the US during the 20th century Mishkin and White (2003) basically conclude that "the key problem facing monetary policymakers is not stock market crashes and the possible bursting of a bubble, but rather whether serious financial instability is present" (Mishkin and White (2003), p. 76). In particular, they demonstrate that the US stock market crash during the years 1999-2000 affected interest-rate spreads to a minor extent, claiming, thus, that that episode of a stock market crash had not been related to financial instability. They further concluded that (at the time of publication) an ad hoc central bank response to the stock market decline was not warranted. They also finally advocated that a focus of the monetary authorities on financial stability as opposed to the stock market could result in an optimal response to stock market fluctuations, reinforcing, thus, the independence of the central bank (Mishkin and White (2003), p. 76).

Chapter 2 discusses in some detail the transmission process which starts with a change in official interest rates. There still remains the issue at which level and how strongly a central bank should react to perceived misalignments in asset prices with respect to fundamental values. Accordingly, this issue is addressed in detail in the following two sections.

## 4.5 Monetary Policy and Asset Prices[79]

Even though typically the monetary policy instrument is an interest rate, other asset prices in addition to those on debt instruments also transmit monetary policy impulses to the economy. Therefore, it is crucial for the monetary authorities to identify the role that movements in these other asset prices are likely to play in the conduct of monetary policy. This section discusses the monetary transmission mechanism through these other asset prices and their role in monetary policymaking.

### *4.5.1 Asset prices in the monetary transmission mechanism*

The three kinds of asset prices that provide important distinct channels of the monetary transmission mechanism, common in the extant literature, are the stock market prices, the real estate prices, and the exchange rates. A brief discussion follows on each case.

[79] This section draws on Mishkin (2001).

(a) Stock Market Prices

Monetary policy influences the stock market fluctuations, which strongly affect the aggregate economy. There are three types of monetary transmission mechanisms with respect to the stock market, namely i) the stock market effects on investment, ii) the firm balance-sheet effects, iii) the household wealth effects and iv) the household liquidity effects.

*i. Stock Market Effects on Investment.* An important evaluation of the effects that movements in stock prices can have on the economy is given by Tobin's *q*-theory (Tobin, 1969). Tobin's *q* is the ratio of the market value of firms to the replacement cost of capital. For high values of *q*, the market price of firms is high relative to the replacement cost of capital, and therefore, the investment on new plant and equipment capital is cheap with respect to the market value of firms. Then the issuing of stock comes at a higher price relative to the cost of buying the new facilities and equipment. Therefore, high values of *q* lead to a rise in corporate investment spending.

The important aspect of Tobin's *q*-theory is the distinction of a link between stock prices and investment spending. Through an effect of monetary policy to stock prices the monetary authorities can, then, exert influence on investment spending and aggregate demand. In detail, expansionary monetary policy lowers interest rates rendering bonds less attractive than stocks and, thus, stirs an increase in the demand for stocks which raises their price. Since higher stock prices lead to higher investment spending, as explained by *q*-theory, higher investment results in higher aggregate demand and a rise in output.

A different view of this mechanism, other than Tobin's *q*-model, is by accepting that companies finance investment not only through bonds but also through equity (by issuing common stock). An increase in stock prices, through expansionary monetary policy, lowers the cost of capital. It renders investment financing for firms cheaper since more funds are produced for each share that is issued. Therefore, a rise in stock prices results in an increase in investment spending[80].

*ii. Firm Balance-Sheet Effects.* Asymmetric information problems in credit markets give rise to another transmission mechanism for monetary policy operating through stock prices. As it has been presented in Chapter 2 this mechanism is referred to as the "credit view", and describes the effect of stock prices on firms' balance sheets. It is often referred to as the balance-sheet channel[81].

Moral hazard and adverse selection problems become more severe as the net worth of firms declines. A decline in net worth implies that for loans made to a firm effectively less collateral can be given. Thus losses from adverse selection potentially increase, which, eventually, results in a decrease in lending to finance investment spending. In addition, a decline in the net worth of business firms makes the moral hazard problem more severe since it implies that firm-owners posses a lower equity stake, inducing them to undertake risky investment projects. As engaging in riskier investment projects increases the probability of default on debt issued on the firm, lower net worth results in a decline in lending and, thus, in investment spending.

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[80] Bosworth (1975) and Hayashi (1982) demonstrate that this alternative description of the link between stock prices and investment is equivalent to the Tobin's *q* approach.

[81] Bernanke and Gertler (1995), Cecchetti (1995) Hubbard (1995, 2001) and Bernake, Gertler and Gilchrist (1999) give surveys on the credit view.

A monetary policy expansion that leads to a rise in stock prices, as stated above, raises the new worth of firms that renders the moral hazard and adverse selection problems less severe, and, thus, increases lending. Higher lending, in turn, leads to higher investment spending and aggregate spending.

*iii. Household Liquidity Effects.* Different balance-sheet channels of monetary transmission involve household balance sheets, in particular liquidity effects on consumer durables and housing expenditures[82]. According to the liquidity effects approach the balance-sheet effects work through their influence on consumer's desire to spend rather than on lender's desire to lend. Consumer durables and housing are considerably illiquid assets due to asymmetric information relative to their quality.

If consumers were in need to increase their income by selling their consumer durables or housing, they would expect substantial losses since in a distress sale it is difficult to get the full value of these assets. On the contrary, if consumers posses financial assets (as for example stocks, bonds, or money deposited in a bank), it would be easy to sell them quickly and at their full market value. Therefore, if consumers more likely expect to find themselves in financial distress, they would prefer to hold more liquid financial assets and fewer illiquid consumer durable or housing assets.

A consumer's fair estimate of the likelihood of suffering financial distress can be drawn from the consumer's balance-sheet. When, for instance, consumers possess a large amount of financial assets in relation to debt, they can estimate a low probability of financial distress and, hence, will be more willing to purchase

[82] See Mishkin (1976, 1977).

consumer durables or housing. After an increase in stock prices, the value of financial assets rises as well. In turn, expenditure in consumer durables will also be higher since consumers are in a more secure financial position and have a lower estimate of the likelihood of suffering financial distress.

*iv. Household Wealth Effects.* An additional balance-sheet channel that operates through consumers involves household wealth effects. The life-cycle model described in Modigliani (1971) explains that consumption is determined by the resources that consumers acquire over their lifetime. A vital component of lifetime resources of consumers is their financial wealth, which tends to be mainly in common stocks. Therefore, a monetary policy expansion that leads to higher stock prices increases the value of household wealth, raising in turn consumers' lifetime resources, that leads to a rise in consumption. This transmission mechanism has been estimated to be quite strong in the United States, yet the size of the wealth effect is still controversial[83].

(b) Real Estate Prices

Real estate prices also play an important role in the monetary transmission mechanism. They can affect aggregate demand in three ways, namely through i) direct effects on housing expenditure, ii) household wealth, and iii) bank balance sheets.

*i. Direct Effects on Housing Expenditure.* Expansionary monetary policy that lowers interest rates leads to a decrease in the cost of financing housing expenditure and

[83] See Modigliani (1971) and Lettau, Ludvigson and Steindel (2001).

therefore increases housing prices. If housing prices are higher than construction costs, construction firms find it more profitable to build housing. The result is a rise in housing expenditure and, thus, an increase in aggregate demand[84].

*ii.* *Household Wealth Effects.* A monetary expansion raises housing prices, which are an important component of household wealth, which in turn affects consumption spending. Therefore a rise in housing prices, raises household wealth, which increases consumption spending and thus aggregate demand.

*iii.* *Bank Balance Sheets.* According to the credit view of the monetary transmission mechanism banks play a special role in the financial system since they are especially well suited to solve asymmetric information problems in credit markets. Then certain borrowers may not be able to access the credit markets except from borrowing from banks[85]. Banks typically undertake a large amount of real estate lending, using the value of the real estate as collateral. If expansionary monetary policy raises real estate prices, banks' losses from default will be smaller increasing, thus, bank capital. A rise in bank capital induces banks to engage in more lending. As banks are 'special with many customers dependent on them', the result is a rise in investment and, subsequently, aggregate demand.

The reverse of the sequence described above, namely when real estate prices fall, has been described as a "capital crunch". This transmission mechanism had been operational in the United States in the early 1990s as described in Bernanke and

[84] According to Mishkin (2001), this approach to housing expenditure is in fact a variant of Tobin's *q*-theory in which *q* for housing investment is the price of housing relative to its replacement cost. For an empirical analysis of a model of this type, see McCarthy and Peach (2001) and Mishkin (2001).

[85] See Kashyap and Stein (1994) and Gertler and Gilchrist (1994).

Lown (1991) and according to Mishkin (2001) has been an important source of stagnation in Japan in recent years.

(c) Exchange Rates

The two main mechanisms identified to operate through exchange rates are the exchange rate effects on net exports and the exchange rate effects on balance sheets[86]. The growing internationalisation of economies and the employment of flexible exchange rate regimes have drawn increasing attention on the effects of monetary policy to exchange rates that influence net exports and aggregate output, in turn. Under a fixed exchange regime this channel of monetary transmission disappears and its impact increases the more open an economy is. A monetary policy expansion influences the exchange rates because it lowers domestic interest rates and, thus, deposits denominated in domestic currency become less attractive to their foreign counterparts. Exchange rate fluctuations also have an impact on aggregate demand through their effects on balance-sheets of financial and non-financial firms when a large part of domestic debt is denominated in foreign currency as, for example, is the case in most emerging markets. Expansionary monetary policy in these countries may also adversely affect aggregate demand if it results in a depreciation of the exchange rate.

To sum up, this section suggests that monetary policy works not just through its direct effects on interest rates, but also through its effects on other asset prices. Since other asset prices are an important element of the monetary transmission mechanism, it is important to evaluate how monetary policymakers can incorporate movements of

[86] See Mishkin (2001) for an analysis on these issues and for related literature.

these asset prices into their decisions about the conduct of monetary policy. Assessing, thus, the role of asset prices in monetary policy, it is worth to discuss how central banks might respond to fluctuations in the stock market prices.

## 4.6 The Role of Monetary Policy under Low Inflation: Deflationary Shocks and Policy Responses[87].

This section develops two main points about the influence of the asset markets on monetary policy. The first is that equity prices can be a considerably misleading guide for interest rate policy actions over the business cycle[88]. The second that several features of the conduct of monetary policy should be understood in order to reflect a central bank's desire to protect market liquidity while maximizing its leverage over longer-term interest rates and aggregate demand[89].

### *4.6.1 Are equity prices a misleading guide for interest rate policy?*

Giving an affirmative answer to the question above, this subsection first presents two cases describing the end of a business expansion when the monetary authorities were not sufficiently pre-emptive. The first is the case of an inflation scare which can lead to a rise in long-term bond rates and give rise to expectations of contractionary monetary policy that will amplify the effects of a recession. In view of the latter equity prices will fall. However, in the effort to control inflation the central bank still

[87] This section draws heavily on Goodfriend (2001) especially, p. 153-160.

[88] See Bernanke and Gertler (2000), Cecchetti *et al.* (2000), Bank for International Settlements (1998), Smets (1997), and Fuhrer and Moore (1992) for quantitative model-based analyses of this issue, and Gertler *et al.* (1998) and Goodhart (1995) for other points of view.

[89] Goodfriend (1998) discusses related issues.

has to stir a rise in short-term real interest rates. This is the case of the go-stop policy cycle in the US during the period before the disinflation of the early 1980s, in particular the stop phase of it.

Otherwise, the central bank can maintain its credibility for low inflation. However, labour markets may eventually tighten due to the business expansion, even to the extent that an increase in unit labour costs may squeeze firm profits. The latter may trigger a fall in equity prices. In this case as well, contractionary monetary policy may be called for in order to control inflation. Yet, in this situation, firm cash flows will be reduced, collateral values will fall, and the equity cost of capital for firms will be less favourable, all leading to a fall in aggregate demand preventing, thus, the use of tighter interest rate policy. Nevertheless, it is the underlying macroeconomic conditions that will dictate the proper direction of interest rate policy, which, in none of the two cases above can be defined from the direction of equity prices.

Another example is the case of rising structural productivity growth that gives rise to improved future income prospects leading households and firms to increase borrowing. With interest rates remaining unchanged, aggregate demand will accelerate in excess of current potential output, leading, thus, to increased employment in excess of the sustainable long-run trend. In turn, labour markets will tighten, and wages will grow faster. However, provided that productivity growth still rises, unit labour costs may remain stable or even fall. This implies that rising productivity may actually finance rising wages (not sparing profits). Therefore, inflation pressures may take time to build up making the central bank reluctant to raise real short-term rates, despite the rising equity values reflecting accelerating profits. When the rising trend in productivity growth stops, the ongoing competition for labour in tight labour markets will cause compensation to catch up to the higher productivity growth path. Then real wages need to grow faster than productivity growth, and, during this transition period, firm profits must grow more slowly. Profit growth slowdown is going to subdue the increase in equity prices, or lead them to decrease[90]. Yet, under these circumstances, the threat of inflation will be more intense than before since labour markets will be even tighter, and firms will not be able to finance further nominal-wage growth from rising productivity. In an effort to control inflation, the central bank may need to raise interest rates irrespective of the behaviour of equity prices.

The above illustrations explain why equity prices can constitute a misleading guide for interest rate policy.

### *4.6.2 Monetary policy, long-term interest rates and aggregate demand*

This subsection gives an outline of the way monetary policy operating procedures allow central banks to maintain liquidity in the financial markets, maximising at the same time the leverage over longer-term interest rates and aggregate demand. Central banks are primarily concerned about supporting liquidity in the financial markets. The main reasons are that a collapse of market liquidity can adversely affect not only asset markets but the economy overall and to a great extent and also because liquid markets are necessary in order to transmit the interest-rate-policy actions from the central bank to the economy.

[90] Goodfriend (2001) indicates the point in Kiley (2000) that "in a production economy with an endogenous interest rate faster productivity growth ultimately lowers the ratio of the market value of firms to output along the new balanced growth path" (Goodfirend (2001), p. 154).

Monetary policy implementation employs either a “quantitative” policy instrument (like the monetary base or bank reserves) or an interest rate instrument (the overnight interbank offered rate). The preference that central banks have shown is for the use of the latter, since an interest rate instrument automatically smoothes short-term interest rates against short-run shifts in the demand for bank reserves and currency. This will always make the supply of bank reserves and currency equal to demand at the intended level of short-term interest rates. In fact, if a financial crisis triggers a sudden increase in the demand for bank reserves and currency, then this is automatically accommodated at the interbank interest rate target.

Yet, aggregate demand makes a direct response only to long-term rate movements, not to movements of the overnight rates. Then, in fact, overnight rates are influenced by central bank policy with the aim of having eventually an impact on longer-term rates. Longer-term rates tend to be determined by the financial market participants as an average of the expected overnight rate over the relevant horizon (allowing for risk of default, and a term premium or liquidity spread). The way leverage is exercised over longer-term rates is described by the following illustration, regarding the pricing of a six-month bank loan. In order to back the issue of the six-month loan, the bank can raise funding from a six-month certificate of deposit (CD), or plan to borrow for the next six months from the overnight interbank market. The competition among banks and cost minimisation broadly equate CD rates to the average expected future overnight rate over relevant horizon. In turn, competition in the loan markets links the loan rates to CD rates. Finally, it is arbitrage that provides a link between other money market rates to CD rates of similar maturity.

Central banks prefer to employ a minimum volatility on the overnight interbank offered rate in order to influence longer-term market rates in their aim to protect market liquidity further. The main underlying reasons are that sudden and large movements in interest rates may threaten liquidity in asset markets, and also that nominal interest rates cannot take a negative value. The overnight rate tends to vary in a highly persistent way and any change is seldom quickly reversed. As a conclusion any single change in the overnight rate affects the stream of expected future overnight rates and in turn longer-term interest rates as well. In other words, by anchoring what is termed as the "short end of the term structure of interest rates" to the overnight rate that is preferred by the central bank, the latter exerts influence on long-term rates with as minimum a volatility in short-term rates.

According to Goodfriend (2001) this line of reasoning justifies two principles in the conduct of interest rate policy by central banks. The first is that "the interbank rate target is changed only when a near-term reversal is relatively unlikely to be desirable *ex post*", while the second is that "a central bank is usually inclined to stick with a target change for a period of time, even if subsequent events suggest that the target change should be reversed quickly… one observes a degree of inertia in a central bank's interest rate policy instrument" (Goodfriend (2001), p. 155)[91].

Furthermore, central banks tend to use discount rate changes[92] and announcements in addition to changes in the interest rate target with the scope of reinforcing their

[91] See Woodford (1999) for a theoretical model of monetary policy on this point.

[92] This point refers to the so-called "Lombard facility" issued for example by the Federal Reserve in the U.S. according to which the rate offered in the "discount window" (the discount rate) is higher than the interest rate target (a federal funds rate in the U.S.) (see eg. The Federal Reserve Bank Discount Window and Payments System Risk website). In this way banks have an incentive to resort to borrowing funds from the central bank after all other alternatives have been exploited.

leverage over longer-term rates imposing the less volatility possible on short-term rates. These practices are intended to signal central bank preferences over several monetary policy stances.

A central bank intensely concerned about economic conditions pointing at an increasing rate of inflation may raise the discount rate in addition to the overnight rate in order to anchor inflation expectations reducing thus the likelihood of a demand for wage and price increases. Conversely, a central bank may lower the discount rate in addition to the overnight rate in order to improve consumer and business confidence and, thus, avoid a decrease in production and spending. These dual changes may prove to be counterproductive if they result in the public misinterpreting the central bank's intensions, and believing that the latter is more worried about recession or inflation than it actually is.

In addition, communication may prove to be vital in stabilizing securities markets after the realisation of a financial shock that leads to a substantial level of default in the credit markets or a break in stock market prices straining market liquidity.

In an effort to reverse this process a central bank can send signals of its commitment to support and stabilise the markets.

A signal of the possible concern of the central bank is send, for example, by a small drop in the interbank-rate target taken relatively quickly, especially if it is accompanied by a discount-rate cut and a statement of concern. The cut in short rates enhances the stabilising of asset prices directly by causing a decline in longer-term rates, and indirectly by stimulating aggregate demand. A rate cut bears risks, however, because the central bank must be prepared to maintain it for awhile (see

Goodfriend (2001) for the reasoning justifying such an attitude by central banks) even if markets bounce back rather quickly. This leads to higher chances of an outbreak of inflation if the economy is already at risk of higher inflation [93]. Furthermore, the central bank can make use of its discount-window facility, if a collapse of lending poses a threat of rendering a liquidity crisis wider and deeper. Goodfriend (2001) stresses on this point that "central bank lending would not undermine its interest-rate target if financed by selling Treasury securities" (Goodfriend (2001), p. 156).

Nevertheless, by relieving financial distress overall, especially on market-makers, the central bank's lending commitment may effectively counter an incipient market liquidity collapse. It is important to emphasise that lending can actually provide time to enable the market in redistributing liquidity. Extending the central bank's lending commitment, however, bears risks. Goodfriend (2001) argues "excessive central bank support of market liquidity would cause banks, market makers, and other beneficiaries of central bank lending to take less care to self-insure themselves against financial distress. Enforcing prudential standards on banks and market makers would help to deter moral hazard. A central bank should limit its lending so that moral hazard does not increase risk in asset markets over time" [94] (Goodfriend (2001), p. 156).

[93] Easy monetary policy in the aftermath of the October 1987 stock market break probably contributed to rising U.S. inflation in the late 1980s.

[94] For a lengthy discussion on how to counter this problem see Goodfriend and Lacker (1999).

### *4.6.3 Monetary policy as a source of deflation and stagnation risk and at the zero bound on interest rates*

This section suggests how monetary policy might contribute to asset price volatility even under price level stability[95]. According to Goodfriend (2001) "[though] asset prices play an important role in amplifying and propagating shocks, they are a conduit rather than a source of deflationary forces" (Goodfriend (2001), p. 156). His analysis identifies monetary policy as a fundamental source of deflation and stagnation risk. He argues that "there are two problems for monetary policy that put an economy at risk of deflation and stagnation when inflation is low. First, a central bank can be fooled by its own credibility for low inflation into being insufficiently pre-emptive in a business expansion. Allowing a boom to go on too long creates the conditions for a bust and a recession after that. Second, although the economy may need low or negative short-term interest rates to stimulate aggregate demand subsequently, interest rate policy can be immobilized at the zero bound on nominal interest rates" (Goodfriend (2001), p. 156).

A central bank may, thus, show a tendency to delay monetary tightening when the economy moves above a presumed level of non-inflationary potential output. The timing and magnitude of interest rate policy actions are rather difficult to determine in any case. Goodfriend (2001) contends that "pre-emptive interest-rate policy actions are difficult to justify to the public when there is little evidence of inflationary pressure… the public might come to believe that the economy has become less prone to inflation… [and] such optimism could support a boom in

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[95] See Shiller (1993), (2000).

spending by households and firms, especially if the central bank exhibits a reluctance to raise short-term interest rates. The plausibly persistent increase in the economy's non-inflationary productive potential would be reflected in a run-up in equity, real estate, and other asset prices" (Goodfriend (2001), p. 157). At some point, however, he notes that, if the economy continued to operate significantly above potential, the price stability credibility would self-destruct. The combination of a collapse in asset prices, open inflation, and declining real economic activity poses difficulties to the central bank. As interest-rate policy at the zero bound is immobilised, there is doubt about whether monetary policy can act against the deficiency of aggregate demand.

Goodfriend (2001) gives a concise summary of the role of asset prices in the boom-bust cycle. He states the following: "Prices of assets such as equity and real estate would exhibit considerable volatility, reflecting the wide range of variation in expected future income prospects. Asset price movements, in turn, would reinforce cyclical volatility by reducing the external finance premium in the boom and raising it in the bust part of the cycle. Asset price volatility, however, should be regarded as a symptom and not a cause of the boom-bust cycle. Rather than focusing on asset prices, central bankers should address the problems for monetary policy that give rise to the potential for economic instability" (Goodfriend (2001), p. 158).

Then he concludes that, certainly, a central bank is not confronted with any good options when an unsustainable boom turns into bust. It, thus, should make every effort in the first place not to be insufficiently pre-emptive during an economic expansion. In order to protect itself from such a possibility, a central bank needs to use a rule that has performed reasonably well in the past as a benchmark to its policy actions [96]. It is also necessary that it positions itself to overcome the zero bound on interest-rate policy (Goodfriend (2001), p. 158).

When inflation is low and stable, a potential problem for monetary policy is, notably, the zero bound on nominal interest rates [97]. When price level stability is fully credible, (annual) nominal short-term interest rates can average at 1 or 2 percent, which does not leave enough room to interest rates to fall in the event of a recession to stimulate aggregate demand. Once a central bank has lowered its interbank interest rate policy instrument to zero, conventional interest rate policy is immobilized. Goodfriend (2001), however, presents an analysis of the two mechanisms according to which monetary policy can still stimulate spending even when the interbank rate is at the cost-of-carry floor[98].

The immobilization of monetary policy at the zero bound would create pressure as to exploit fiscal policy in order to stimulate aggregate demand. However, as Goodfriend (2001) argues "it seems that fiscal policies might be costly, relatively ineffective at best, and counterproductive at worst"[99] (Goodfriend (2001), p. 161). It has to be stressed at this point, though, that the above statements seem to overestimate the role of monetary policy in deflationary conditions, and perhaps underestimate the role of

[96] See Taylor (1999a). In addition, Orphanides (1998) stresses that it is very difficult to measure the output gap in real time. His analysis suggests that central banks should respond mainly to inflation and downgrade the response of the interest-rate to the output gap in the policy rule. The argument in Goodfriend (2001) suggests that, "with credible price stability, responding only to inflation has problems of its own", and "central banks need to respond to real measures of inflationary potential so as not to be insufficiently pre-emptive in a business expansion" (Goodfriend (2001), p. 158).

[97] See also Goodfriend (2000), (2001), (2003), McCallum (2000), and Fujiki et al. (2001) for a related discussion and analysis of the zero interest policy of the Bank of Japan.

[98] See Goodfriend (2001) for the analysis of the two mechanisms by which monetary policy can continue to stimulate spending when the interbank rate is at the cost-of-carry floor.

[99] See Goodfriend (2001) for the fiscal policy pitfalls and a distinction of three types of fiscal policy, namely debt-financed government investment in public capital, a debt-financed cut in taxes, and microeconomic interventions and regulations to support incomes in specific sectors.

fiscal policy. According to White (2001) there is "no convincing empirical evidence that fiscal multipliers are less than one, much less zero" (White (2001), p. 171). Nevertheless, the way in which fiscal stimulus is conducted is certainly important. He, further, adds that if monetary and fiscal policies are crucial during a deflationary period, so is bank restructuring, as well. He contends that "arguably, deflation having negative implications for growth[100] only occurs when financial instability is a major complicating factor. It could be added also that based on successful experience in the Nordic countries in the early 1990s, a prompt official response should also be definitive, free from political interference, and wholly transparent with respect to the burden of costs above all" (White (2001), p. 171). It is noted that in many countries, bank restructuring does not qualify for these requirements even to a minimum extent. Finally, as also Goodfriend (2001) states, "when it is the general public that refuses to face up to reality, then the public perhaps gets both the government and the form of bank restructuring which it deserves" (White (2001), p. 171).

## 4.7 Concluding Remarks

Bearing in mind that a generally accepted definition of financial stability has not emerged in the literature, and besides the tendency to define financial instability instead, there exists a clear distinction between definitions that refer to the volatility of directly observable financial variables and those that are based on a system approach. The latter tend to broadly follow Mishkin (1991), which can be adapted

[100] See BIS (1999), chapter IV. Since the late 1800s, periods of deflation have also generally been periods of positive (if moderated) real growth. The principal exception to this was the first few years of the Great Depression of the 1930s.

according to Issing (2003) to a broad, but intellectually convincing definition of financial stability as "the prevalence of a financial system which is able to ensure in a lasting way, and without major disruptions, an efficient allocation of savings to investment opportunities" (Issing (2003), p. 16). The degree of financial fragility can then be viewed as the proximity of the economy to the break point, exceeding that which would impair the efficient allocation of savings (Issing (2003), p. 16).

Asset prices tend to exhibit considerable volatility, being a sign of the wide range of variation in expected future income prospects. Movements in asset make cyclical volatility more intense as they reduce the external finance premium during the boom phase and increase it during the bust. Nevertheless, asset price volatility seems to be a symptom rather than a cause of the boom-bust cycle, and, therefore, monetary policymakers need principally to address any monetary policy problems that may potentially create economic instability.

Finally, this chapter explored the relationship between monetary policy, deflation and financial stability. After reviewing financial stability (or its negative counterpart), we discussed price stability and financial stability and provided a brief analysis of the relationship between asset prices, monetary policy, and the consequences of financial distress for banking crises or simply movements in asset prices. It is argued that equity prices, in fact, constitute a misleading guide for interest-rate monetary policy, in addition to the fact that monetary policy actions exercise significant protection to market liquidity and maximise a central bank's leverage over longer-term interest rates and aggregate demand. Monetary policy is also argued to be a fundamental source of deflation and stagnation risk in a regime of fully credible price level stability. Two main issues of concern for monetary policy remain, though, namely that a central bank can be insufficiently pre-emptive in a business expansion, while being misled by its own credibility for low inflation. Monetary policy may face the constraint of the zero bound on nominal rates in its attempts to reduce real interest rates enough in order to forestall deflation and stagnation in the subsequent contraction (as discussed in Goodfriend (2001), (2003)).

As White (2001) suggests it is crucial to answer the question of how a country enters into a deflationary situation. He suggests that "the answer can be succinctly expressed in two words, 'boom' and 'bust'…" (White (2001), p. 167). Goodfriend (2001) stresses a simple but fundamental point referring to the problem arising in the 'boom' phase of an economic cycle. It is concluded that "justified optimism can turn into excessive optimism; rational enthusiasm can turn into irrational exuberance. The "good news" of low inflation can blind both policymakers and market participants to emerging problems" (White (2001), p. 167).

# CHAPTER 5
# ASSET PRICE BUBBLES: AN OVERVIEW

## 5.1 Introduction

Monetary policymakers are confronted with no other alternative but to encounter the risks caused by asset price bubbles. Bubbles in asset prices create distortions to nearly all economic decisions. Wealth effects create rapid expansions in consumption followed by vast collapses. Increases in equity prices enable firms to finance new projects, causing a boom in investment, followed by a bust. The overvaluation in collateral used to back loans leads to balance-sheet deteriorations for the financial intermediaries that issued the loans, after the prices collapse. In addition, fiscal revenue rises in a booming economy, and encourages, thus, cuts in taxation and increases in expenditure. After the consequent, inevitable, slump in asset prices such fiscal policy actions are politically difficult to reverse. Therefore asset price bubbles can create volatility in consumption, investment, financial intermediaries' solvency, and fiscal policy. They, usually, have an impact on aggregate demand, since they cause inflation and output to increase during the boom and decrease during the bust. Therefore, monetary policymakers are faced with no other alternative but to address the issue of asset price misalignments – even when their primary objective is price stability.

In the effort to evaluate the ways in which monetary policy (as well as public policy in general) should address bubbles in asset prices, one must first identify the ways in which asset prices influence inflation and aggregate economic activity. As those influences span through various channels, asset prices send signals with respect to profitable investments, influence household wealth, and affect the cost of capital for firms and households. Increases in equity prices, for example, irrespective of the source – be it bubble-behaviour like “irrational exuberance” or a shift in fundamentals like lower real interest rates or faster productivity growth, tend to lower the cost of capital, boosting investment, and to generate increased wealth, raising, thus, household demand. The resulting fluctuations in resource utilization lead to changes in inflation.

Of course, asset price bubbles have additional implications for economic efficiency. Departures of asset prices from levels implied by economic fundamentals can lead to inappropriate investments that decrease the efficiency of the economy by diverting resources toward economic activities that are supported by the bubble (for example, see Dupor, 2005). For example, during the bubble in technology-stocks in the late 1990s, there was overinvestment in some types of high-tech infrastructure. Similarly, the bubble in housing prices led to too many houses being built. Mishkin (2008), in particular, views these distortions to activity across sectors of the economy as a ‘drag on efficiency’ and hence a matter of concern above and beyond fluctuations in overall economic activity and inflation (Mishkin (2008), p. 8). In addition, he remarks that monetary policy is directly concerned with the effects changes in asset prices impose on inflation and demand through wealth and cost-of-capital channels. Bearing, though, in mind that asset price bubbles may vary (sometimes to a great extent), it is important to note that some types of asset price bubbles may fall beyond the direct responsibility (or circle of influence) of monetary policy but be more appropriately countered by the broader regulatory framework safe-guarding the financial system. He, finally, contends that some asset price bubbles may also stir financial instability, and as such raise further substantial concerns for the policymakers (Mishkin (2008), p. 1).

The main function of the financial system is to channel efficiently funds from savers to individuals or corporations that present worthy investment opportunities. In the presence of shocks obstructing the flow of information that is vital for the smooth operation of the system, the latter may be disrupted giving rise to financial instability. The subsequent disruption in the credit flow may eventually threaten overall economic performance[101]. The efficiency in the operation of the financial system is based on the flow of information that is yet asymmetric in its nature. This asymmetry refers to one part in an investment project, which is typically the provider of the funds – the lender, being less accurately informed about the project than the other that will carry out the investment – the borrower. This type of asymmetry in information can give rise to 'adverse selection' and 'moral hazard' that hamper the efficient operation of the financial system[102] (Mishkin (2007a), p. 1-2).

Financial intermediaries, and especially banking institutions, manage to reduce the above informational asymmetry by efficiently collecting information from borrowers and building a strong network with their clientele. The growth of financial innovation,

[101] See, for example, Mishkin (1997) for a detailed account of the causes of financial instability and its effect on economic activity.

[102] Adverse selection describes the problem of financial intermediaries issuing loans to investors who are willing to assume excessive risk because they are unlikely to pay back their loans. Moral hazard describes the problem a borrower having incentives to undertake excessively risky investments in which the lender bears most of the cost in case of failure but the borrower gets a high benefit in case of success. See Milgrom and Roberts (1992) for a detailed discussion.

either as new financial products and new types of institutions active in the markets, enabled the more efficient flow of information. The latter minimises the problems of 'adverse selection' and 'moral hazard' and is principal in the ability of the participants in the financial markets to collect relevant information and properly evaluate the value of assets traded in the financial markets (termed as 'price discovery').

However, the flow of information may be disrupted, and price discovery may be impaired during periods of financial distress. The increased uncertainty that characterizes the disruption in the information flows results in high risk spreads and a reluctance to purchase assets[103].

Moreover, during a recession, the deterioration of balance-sheets renders ineffectual the use of collateral as a remedy to the adverse selection and moral hazard problems. If a loan is backed by collateral, in the case of default, namely after the lender has in effect made an adverse selection, the lender obtains the collateral as compensation. Considering moral hazard, the collateral works as a penalty for the borrower in case extra risks are assumed that may jeopardise the project, reducing thus the problem of moral hazard. Yet as the overall economic outlook deteriorates, collateral values tend

[103] In an effort to understand financial instability, it is vital to address two kinds of risk, valuation and macroeconomic risk. The first one reflects the difficulty that the market faces in assessing the value of a security, due to the inherent complexity of the security or the opaqueness of its underlying creditworthiness. According to Mishkin (2007b), "valuation risk has been central to the repricing of many structured-credit products during the [recent] turmoil … when investors have struggled to understand how potential losses in subprime mortgages might filter through the layers of complexity that such products entail" (Mishkin (2007b), p.2). In turn, macroeconomic risk refers to the increase in the probability that a disruption in the financial system will deteriorate the real economy to a great extent. Such episodes tend to give rise to a vicious circle as real economy deteriorations increase the 'opaqueness in the creditworthiness' of the securities traded in the financial markets, financial disruptions lead to a decline in investment and consumer spending leading, thus, to a contraction in overall economic activity. This contraction leads to an increase in the uncertainty referring to the value of assets making the financial disruption more acute (Mishkin (2007b), p.2).

to deteriorate as well, making the above two problems more acute. As lenders, in turn, show a relative reluctance to issue loans, a vicious circle may be in effect reinforcing, thus, the macroeconomic downturn.

Shocks interfering with the flow of information in various parts of the financial system precipitating financial instability span from higher interest rates (that may give rise to credit rationing) to problems in the banking sector (as a weakening in the financial positions of several financial intermediaries), and increases in uncertainty to asset-market effects on balance-sheets. Financial instability, in the absence of any remedial action, can produce a severely adverse impact not only for the functioning of financial markets but also for the overall prospects of a country's economy. This strong link between financial stability and the real side of an economy renders the former a principal concern for central banks. Monetary policy authorities face the central concern of finding and evaluating ways to prevent financial instability. In this endeavour one needs, first, to understand the nature of financial instability and the effect it may impose to the macroeconomy.

As Mishkin (2008) points out, financial history shows a sequence of events that typically proceed in the following manner. Stemming from either excessive optimism about economic prospects or fundamental changes in the structure of the financial system, a boom in credit provision takes place, which leads to higher demand for certain assets and, in turn, to higher prices for those assets[104]. The latter raises the values of those assets, consequently, promoting further issuing of credit backed by those assets, which further raises demand and, thus, the prices of those assets. Such a

[104] For a detailed account of this point see, for example, Kindleberger (2000) and Mishkin (1991).

reinforcing mechanism can create a bubble. The latter can encourage lax credit standards since lenders rely more on the further appreciation of the pertinent assets (in order to shield themselves from potential loss) than on the borrowers' ability to repay the debt issued to them. When the bubble (inevitably) bursts the mechanism described above works backwards. The drop in asset prices causes a decrease in supply of credit, and as the demand for assets continues to fall their prices drop further. Loan defaults and the slump in asset prices deteriorate the balance-sheet positions of financial institutions leading to a further decrease in credit supply and investment. Business and household spending shrinks as a result of the decline in lending. In turn overall economic activity deteriorates and macroeconomic risk in credit markets increases. Finally, "in the extreme, the interaction between asset prices and the health of financial institutions following the collapse of an asset price bubble can endanger the operation of the financial system as a whole" (Mishkin (2008), p. 2).

## 5.2 Remarks on the Policymaker's Reaction to Asset Price Bubbles

Initially, it is useful to refer to Trichet (2003), who recognizes two main reasons explaining the growth in asset prices and wealth effects during the last fifteen years. The first is the dramatic change in asset valuations stemming mainly from the rise in the stock prices of the so-called "new economy" during the mid 1990s and their collapse in 2000[105]. The second refers to the effect that widespread share-ownership

[105] Besides the United States (where the above is well documented) the rise in stock prices has been considerable even in Europe, where the influence of the "new economy" had been relatively modest (Trichet (2003), p. 15).

in several industrialised countries has on the influence of the above changes in asset valuations to private spending relative to the past[106] (Trichet (2003), p. 15). These issues raise the concerns of whether monetary policy should react to movements in asset prices. Large swings in asset prices may jeopardise the principal monetary policy objective of price stability and may also hamper financial stability, which is of major concern to central banks.

Asset prices can play a significant role in the conduct of monetary policy. The role of asset prices in the monetary policy transmission mechanism has been discussed in Chapters 4. Briefly, the effect of changes in the policy rate may be transmitted to asset prices and asset valuation through several channels. Interest rate changes affect expectations about future economic prospects and consequently profit expectations. In addition, such changes alter the set of discount factors applied on profit expectations or used in order to determine the value of assets. Finally, monetary policy decisions may also result in changes in portfolio composition affecting the relative prices of the pertinent assets (Trichet (2003), p. 16).

Furthermore, the wealth effects that changes in asset prices may create, and which exert a significant influence over consumption and investment, pass on to the economy through several channels. Briefly, these channels include a direct net-wealth increase that raises consumption via intertemporal smoothing of consumption from households, changes in Tobin's *q* that stimulate corporate investment, or higher collateral values that may lessen external financing constrains and boost spending.

[106] For example, market capitalization as a percentage of gross domestic product in France increased from 28 percent to 110.5 percent during the 1990s. The share of household equity holdings in financial assets increased as well (Trichet (2003), p.15).

Changes in asset prices may also trigger confidence or expectations channels that affect corporate and household spending decisions (Trichet (2003), p. 16).

Asset price misalignments may also raise the risk of creating financial fragility that can give rise to adverse economy-wide events. Normally, financial innovation leads to more efficient risk sharing, in that risk is undertaken by the most able to bear it resulting, thus, in smoother consumption. However, more efficient risk sharing enhances the potential for concentration of risk to individuals willing to do so. According to Cecchetti (2005) risk concentration, in particular inside leveraged institutions can raise the potential of creating financial fragility. He further remarks that, "as the risk managers of the economic and financial system, policy makers are forced to care about bubbles" (Cecchetti (2005), p. 4).

In the presence of acceptable evidence that asset price fluctuations do not correspond to fundamental levels and with the uncontested recognition of the potential damage asset price bubbles can cause to the economy, both policymakers and academic researchers fail to accept the proposition that bubbles should be ignored. Yet the crucial issue for policymakers is to devise a proper reaction.

It seems illustrative enough to adapt a classification of possible policy reactions provided by Cecchetti (2005) who identifies five suggested responses:

(i) 'Consider bubbles only if they influence forecasts of future inflation'.

(ii) 'Act only after the bubble bursts, reacting to the fallout of the bubble'.

(iii) 'Include asset prices directly in the price index targeted by the central bank'.

(iv) 'Lean against the bubble, raising interest rates in an attempt to keep it from enlarging'.

(v) 'Look for regulatory solutions both to keep the bubble from developing and to reduce the impact of a crash should one occur' (Cecchetti (2005), p. 14).

Each suggested response is considered in more detail below. Initially, it is essential, to stress that asset price targeting, namely, a policy response as in (iii), is rejected by both academics and policymakers as an inappropriate policy reaction. Cecchetti (2005) remarks that policymakers should not target asset prices per se, nevertheless, recognizing that "the proposal that interest rates respond to bubbles is completely consistent with inflation targeting or any other policy framework based on standard stabilization objectives" (Cecchetti (2005), p. 15). This is advocated also, for example, by Cecchetti, Genberg, and Wadhwani (2003) who stress that: "It is our view that central banks can improve macroeconomic performance by *reacting* to asset price misalignments. We are not now saying … that policymakers should *target* asset prices" [emphasis is in the original] (Cecchetti et al. (2003), p. 428). As well as their further remark: "We want to emphasize that we are *not* advocating that asset prices should be *targets* for monetary policy, neither in the conventional sense that they belong in the objective function of the central bank, nor in the sense that they should be included in the inflation measure targeted by the monetary authorities" [emphasis is in the original] (Cecchetti et al. (2003), p. 429).

Shiratsuka (1999) analyses the appropriate inclusion of asset prices in the price index and concludes that it is very difficult to construct such a price index. The main reasons he gives are first that the accuracy and coverage of asset price statistics are low, that several factors affect the changes in asset prices and, finally, that they are significantly influenced by economic and financial developments. A number of the principal conceptual and implementation-based issues against the inclusion of asset prices in a price-index relevant for policy (i.e. against asset-price targeting[107]) present in the academic literature are also concisely given in ECB (2005). In particular:

1. Two main reasons are identified against the use of asset prices as a proxy for future goods prices. First, in the case of the inclusion of asset prices in the pertinent price index, in theory, such an index should include all assets, comprising also the value of consumer durables and human capital. Second, movements in asset prices may not relate to future inflation expectations. Then, in a central bank's effort to device the appropriate reaction to asset price inflation, it has to determine the fundamental value of assets promptly and accurately[108].

2. Asset-price targeting tends to establish a rather 'mechanical' policy response that may give rise to moral hazard problems. Since monetary policy would be expected to stabilise asset prices, investors' risk taking behaviour would increase[109].

3. Asset-price determination and forward-looking monetary policy may give rise to 'inflation indeterminacy'. Inflation expectations can become self-fulfilling, under certain conditions, when central bank policy responds to asset price movements since asset prices are partly affected by expectations about future monetary policy. This may lead to inflation indeterminacy and potentially high inflation volatility[110].

[107] The term 'target' usually refers to an explicit central bank objective. However, Cecchetti (2005), for example, uses the term rather loosely to mean either an explicit or implicit objective.

[108] See, for example, Filardo (2000), as well as Diewert (2002) and Smets (1997).

[109] See Goodhart and Huang (1999).

[110] See Bernanke and Woodford (1997).

4. The benefit of explicitly targeting asset prices which tend to be a 'deficient' proxy for future consumer prices seems unclear, if central banks credibly and successfully pursue their consumer price stability objective, stabilising, thus, future inflation expectations[111]. In fact, this may be considered as the monetary policymaker double-counting consumer price pressures in its information set.

5. In order to construct a price index that includes asset prices it is vital to determine the weight given to prices of current consumption goods and assets. Traditionally, the method used focuses on expenditure shares, and the resulting weight of asset prices may be higher than 90 percent, leading to a highly volatile monetary policy. Some other methods used relate the shares to forecasting ability of future consumption prices. The resulting weights may vary considerably with respect to the method in use[112].

6. Any attempt by the central bank to affect asset prices in a systematic way seems to be pointless, making the presumption that "monetary policy cannot control the fundamental factors which affect asset prices in the long run" (ECB (2005), p. 56-57).

To sum up, severe asset price fluctuations can potentially destabilise inflation and output to a dramatic extent. More importantly, they pose substantial down-side risks, which cannot be ignored by central banks. However, a suitable monetary policy reaction to misalignments in equity prices, property prices or the exchange rate necessitates an accurate estimation of the relevant numerical size, which is not easy

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[111] See, for example, Bernanke and Gertler (2001), also Cecchetti, Genberg and Wadhwani (2003).

[112] See, for example, Bryan, Cechetti, O'Sullivan (2003).

to accomplish. Nevertheless, as argued by Cecchetti, Genberg, and Wadhwani (2003), not only is such measurement vital in forecasting inflation and growth, but also it is not more difficult than the critical (for policy design) estimation of potential GDP for example (Cecchetti, Genberg, and Wadhwani (2003), p. 440). In addition, Cecchetti (2005) contends that "policymakers do not usually shy away from important issues just because the solution is difficult" (Cecchetti (2005), p. 20). It is important to address the proposed policy reactions in more detail.

*(i) React only if the bubble changes inflation forecasts:* This proposition rests in the face of substantial evidence that a bubble may be in progress. Influential advocates of this proposition have been Bernanke and Gertler (1999, 2001). Their main point is that if monetary policy reacts to booms in asset prices directly, then it faces the possibility of destabilising real output and inflation. Therefore, they view an appropriate monetary policy response only insofar the forecasts to inflation are explicitly affected by the sharp fluctuations in asset prices. Bernanke and Gertler (1999) reach the conclusion that: "The inflation targeting approach dictates that central banks should adjust monetary policy actively and pre-emptively to offset incipient inflationary and deflationary pressures. Importantly, for present purposes, it also implies that policy should *not* respond to changes in asset prices, except insofar as they signal changes in expected inflation" [emphasis is in the original] (Bernanke and Gertler (1999), p. 78)[113]. However, Cecchetti, Genberg, Lipsky, and Wadhwani (2000), Cecchetti, Genberg, and Wadhwani (2003) and Cecchetti (2005) reject this conclusion on the grounds of the definition of monetary policy in Bernanke and Gertler (1999, 2001). In particular, they note that the latter address simple rules for

[113] This view has also been concisely presented in Bernanke (2002).

monetary policy which do not contain the possibility of any responses of interest rates to output gaps, and that if, in fact, the number of possible monetary policy rules is expanded a reaction to asset price bubbles will tend to be stabilizing. Taking into account that monetary policy is essentially the adjustment of the policy instrument in response to shocks so as to reach the relevant stabilisation objectives, Cecchetti (2005) remarks that, in Bernanke and Gertler (1999, 2001) framework (which is the same as in Cecchetti, Genberg, Lipsky, and Wadhwani (2000)) "bubbles are just another type of shock to which interest rate policy should react, and as an empirical matter … reacting to bubbles over and above their impact on forecasts of future inflation yields more stable inflation and real growth" (Cecchetti (2005), p. 15).

Any attempts of the central bank to "prick" the bubble, i.e. to intervene with a vigorous tightening of policy in order to counter speculation, would take place in a rather late stage in the maturity of the bubble. The central bank increases the cost of maintaining a speculative position in the market in order to lead the most stretched positions to liquidation.

Nevertheless, any such attempts have certain crucial shortcomings. According to ECB (2005), initially, "experience indicates that the market reaction to such an abrupt change in the prevailing monetary conditions is highly unpredictable" (ECB (2005), p. 57). Furthermore, they necessitate considerably large changes in interest rates, which, in turn, bare substantial economy-wide risks. Moreover, in the event of a bubble being resilient to initial corrective action (in terms of aggressive interest rate policy), in the next phase, it may be the case that even marginal interventions may trigger a generalised sell-off, that may make the contraction even more intense[114]. In particular, ECB (2005) argues that "a policy of 'pricking the bubble' is not a viable option for a stability-oriented central bank" (ECB (2005), p. 57).

*(ii) Clean up after the bubble bursts:* According to Greenspan (2002) monetary policy is inefficient before the bubble bursts and that the appropriate response can only be to eliminate the adverse consequences. In particular, he contends that a policymaker can be certain that a bubble did, in fact, exist only after it unwinds. He also remarks that "no low-risk, low-cost, incremental monetary tightening exists that can reliably deflate a bubble" (Greenspan (2002), p. 5).

In response to this view Cecchetti (2005) argues that asset price bubbles can be identified both theoretically and in practice. He views, for example, large movements in the ratio of housing price sales to rental values or the ratio of market prices to replacement costs as an important signal that a bubble is underway[115] (Cecchetti (2005), p. 15). Further support is given by Borio and Lowe (2003) who stress that other 'financial imbalances' tend to present in addition to bubbles in asset prices, such as high money-growth or build-ups in debt accumulation. Secondly, as mentioned above, Cecchetti, Genberg, and Wadhwani (2003) point out that the appropriate measurement of asset price misalignments is not more difficult than the critical (for policy design) estimation of potential GDP for example (Cecchetti, Genberg, and Wadhwani (2003), p. 440). Finally, the experience in Australia during (roughly) 1999-2005, where increases in interest rates in addition to effective

[114] White (1990), among others, attributes the persistence and intensity of the Great Depression to the US Federal Reserve System's efforts to 'prick' an ongoing stock market bubble.

[115] According to Bean (2003) it would be erroneous to undertake 'mechanical' responses to changes in asset prices alone – irrespective of the fact that proportional changes in rents and earnings also take place.

communication of the view that asset price increases (in this case housing) are sustainable, can be an example of effective policy response countering an asset price bubble. In this case the Reserve Bank of Australia managed to contain the increase in housing prices in early 2004 (which remained stable at least for the next two years) after an interest rate increase of ten percent for six consecutive years (Cecchetti (2005), p. 16).

*(iii) Include housing prices in the target index:* A potential response to bubbles that may stem from the housing market may be the direct inclusion of housing prices in the price index targeted by the central bank. General arguments against asset price targeting are stated above. However, referring specifically to housing prices, Bryan, Cecchetti, and O'Sullivan (2003) propose that the value of existing homes must have a weight in the price index used by the central bank in order to measure aggregate inflation[116]. Cecchetti (2005) suggests that "targeting an index that includes the acquisition cost of housing would change things dramatically" (Cecchetti (2005), p. 17).

*(iv) Use interest rate policy to 'lean against the bubble':* In this case, in response to accelerating asset prices the monetary policymaker adopts a more restrictive policy stance than under more normal market conditions and attempts in an early stage to

[116] Bryan, Cecchetti, and O'Sullivan (2003) argue that policymakers should be stabilizing the cost of lifetime consumption, instead of simply per period consumption, which implies that assets need to be taken into account as they are the prices of entire streams of lifetime consumption. Their analysis suggests that housing, for example, (i.e. giving housing services over a lifetime) must be included in the price index at its current market price (see also Goodhart and Hofmann (2000)). Their analysis builds on the seminal work of Alchian and Klein (1973) who accept that the change in the price of a given level of utility, which includes the present value of future consumption is a theoretically correct measure of inflation. In order to estimate inflation accurately, they argue, a broader price index is necessary than one consisting of only the prices of current consumption goods and services. They view that central banks should target a price-index including asset prices in order to incorporate the price of future consumption. Conversly, Filardo (2000) argues against the inclusion of housing prices in an index of inflation as it would not substantially improve economic performance (he refers to the US, but draws general conclusions).

avoid inflating the bubble which would have been the case with accommodative monetary policy. Therefore, in the shorter term, the central bank may deviate from its price-stability objective, so as to reinforce the prospects of price and economic stability in the future (ECB (2005), p. 58).

Cecchetti, Genberg and Wadhwani (2003) argue in favour of a policy of "leaning against the wind of an incipient asset-price bubble" similar to the policy adopted by the Reserve Bank of Australia in 2003. Among others, Dupor (2005) presents a sticky-price model where firm investment in physical capital exceeds the required level at the face of a bubble in equity prices[117]. In such an event, the most suitable reaction for the central bank would be to raise interest rates, so as to lower the marginal product of capital, and, thus, depress equity prices. Such optimal policy is the one often referred to as 'leaning against the bubble'[118].

Moreover, empirical evidence on this kind of policy is given by Cecchetti (2003) who shows that the U.S. Federal Reserve, in fact, modestly increased interest rates reacting to the stock-price boom of the late 1990s. Cecchetti (2005) argues that asset-price bubbles simply present some "form of destabilizing shocks to which policymakers need to react" (Cecchetti (2005), p. 16). Since movements in asset prices influence aggregate demand, altering inflation and the output-gap in the same direction, then monetary policy can, in principle, neutralize these shocks.

[117] In his model nominal rigidities distort allocations within the economy for a certain specific time, yet equity bubbles distort saving and investment decisions over time. According to Dupor (2005), since the monetary policymakers possess a single interest rate instrument and face those two problems, the optimal policy needs to react to both distortions.

[118] According to Bean (2003), for New-Keynesian macroeconomic models this is a general result. Furthermore, in order to avoid credit crunches central banks would generally resort to increases in interest rates.

ECB (2005) notes that "a policy of 'leaning against the bubble' would appear more attractive the higher the costs that the central bank ascribes to large, fundamentally unjustified swings in the valuation of assets and the more serious the risk that – if left unchecked – market movements would tend to gain momentum as time progresses" (ECB (2005), p. 58). This kind of policy bears limited risks when the underlying reason of the increase in asset prices is widespread optimistic expectations about future rises in productivity. If proven ex post that the optimistic private expectations were exaggerated, the prompt implementation of tighter policy at an early stage would be justified as capable of restricting the general unjustified optimism. If the monetary policymakers impose at an early stage tighter credit conditions, the increase in market valuations can be confined rendering the eventual collapse less disruptive for the economy. On the other hand, if the expectations are confirmed ex post, then the increase in productivity and the enhanced growth prospects will diminish the cost from the tighter policy (ECB (2005), p. 58).

Symmetry is also a strong argument in favour of the 'leaning against the bubble' policy. In this case, the central bank does not create the expectation that it will support the economy when asset prices slump and abstain when prices rise, thus countering the possibility of systematic under-pricing of risk. This practice discourages speculation from the part of the financial markets participants, restraining the growth of the bubble. Symmetry also enhances the appropriate policy design after the bubble unwinds as the risk of the policymaker's encouraging moral hazard behaviour in the future is minimised (ECB (2005), p. 59).

However, Gruen, Plumb, and Stone (2005) argue against the practice of 'leaning against the bubble'. They show that this interest-rate policy response is impractical mainly because even though interest rates impose a direct effect to the bubble, they influence economic activity with a lag. Due to the latter, output falls following the bursting of a bubble, and the central bank would prefer to keep interest rates low for some period before a crash. However, the probability of the bubble bursting is reduced in response to lower interest rates, thus, increasing the bubble. They further demonstrate that for stabilization policy to be successful the central bank needs to identify the bubble in the early stages of its growth, which is extremely difficult to accomplish accurately. Gruen, Plumb and Stone (2005) remark that "there is no universally optimal response to bubbles, and the case for responding to a particular asset-price bubble depends on the specific characteristics of the bubble process" (Gruen, Plumb and Stone (2005), p. 3). Cecchetti (2005), nevertheless, points out that probably interest-rate policy is not the most suitable response to asset-price bubbles (Cecchetti (2005), p. 16).

ECB (2005) remarks that further disadvantages of such a policy may also be, initially, that in the case of asset appreciation being generated by actual structural imbalances, policies other than monetary policy may be appropriate to address the issue. Furthermore, markets tend to overreact even to a small extent to a policy intervention, even when the later is gradual and over a longer time-horizon. Finally, the policymaker runs the risk of encouraging the market participants to perceive that monetary policy reacts in a rather automatic way to asset price developments (ECB (2005), p. 59).

*(v) 'Unconventional alternatives'*: In addition to interest-rate policy alternative policies may prove to be helpful when bubbles are due to structural changes. ECB (2005) remarks that, in this case, it may be more relevant to implement prudential

regulation measures or tax code changes, or an overhaul of government transfers and subsidies (ECB (2005), p. 59). Moreover, Cecchetti (2005) points out the presence of unconventional alternatives to counter asset price bubbles. He questions whether changes in the financial market structure are necessary. In particular, he argues of the following: "are primarily bank-based financial systems more prone to difficulties? Should we strive to increase the importance of secondary financial markets? Or, alternatively, move toward narrow banks? The problem with this is that financial innovation cuts both ways. By making it easier to trade risk, it means that risk can go both to those best equipped to bear it and to those willing to accumulate it" (Cecchetti (2005), p. 19).

Furthermore, financial development is also viewed with caution despite its uncontested merits. The latter span from enhanced economic development to lower volatility of economic growth since it enables consumption and investment smoothing through enhanced risk-sharing in the event of higher volatility in income and sales. However, Cecchetti (2005) remarkably views the possible shortcomings when addressing housing bubbles as follows: "By providing households with a mechanism for increasing leverage, especially through mortgage lending, the financial system could be increasing the chances of catastrophe. Ready access to loans allows individuals to bid up the prices of existing homes and has the potential to create frenzies that result in booms followed by crashes – e.g. bubbles. The risk is that when the bubble bursts there will be a large number of defaults"[119] (Cecchetti (2005), p. 19).

[119] In fact, Cecchetti (2005) concludes that, with reference to housing bubbles, "interest rates are likely to be the wrong instrument for addressing the risks [this kind of] bubbles create" (Cecchetti (2005), p. 19) and proposes two possible solutions that focus on the increase in credit provision that inflates the

## 5.3 Theory and History of Asset Price Bubbles

International experience gives several examples that demonstrate the interaction between financial stability, asset price bubbles, and the conduct of monetary policy. This is the focus of this subsection. The 'Great Depression' in the U.S. and the economic boom that preceded it are highly illustrative events[120]. The stock market boom has been attributed to lax credit control and rising speculation which ended with a panic-selling when the stock price progress reversed which triggered the 'Great Depression'[121]. In this view, the U.S. Federal Reserve should have used restrictive interest-rate policy to prevent market speculation and withhold the rise in equity prices[122]. According to Mishkin (2008), at the time the US Federal Reserve not only erred on its attempt to burst the bubble directly, but also in failing to change the policy stance promptly after the collapse of the stock market and the problems in the banking system set in, in this way giving rise to deflation, which, in turn, lead to

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bubble. These are either to use regulatory mechanisms in order to restain lenders, which would entail supervisory adjustments for risk-based capital requirements, or try to restrict borrowers. While viewing the former as rather complex, Cecchetti (2005) argues on the latter as follows: "The alternative is to adjust borrower-loan qualification requirements to the environment. For example, the maximum loan-to-value ratio could depend on deviations in rent-to-sale price ratios from their lagged moving average (or on the rate of recent increase). Alternatively, income coverage tests could depend on long-term interest rates rather than short-term interest rates. There are many possibilities, and we need to explore them" (Cecchetti (2005) p. 19).

[120] The economic boom in the U.S. economy lasted during 1923-1929. It grew as collective optimism spread in the introduction of financial innovations, new technologies and improved business practices (Mishkin (2008), p.4). The stock market 'Great Crash' in 1929 ended the process.

[121] See, among others, Galbraith (1954) and Kindleberger (2000).

[122] However, Galbraith (1954) and White (1990a), for example, argue that the equity bubble only started in March 1928. Mishkin (2008) reports that the US Federal Reserve was highly concerned about the raising equity prices. In fact, Adolph Miller (member of the Board) heatedly advocated in favour of an interest-rate increase in order to restrain speculation and the subsequent rise in credit, while Benjamin Strong (Governor of the Federal Reserve Bank of New York) opposed it in fear of an adverse impact to the economy arguing that "…any effort through higher rates directed especially at stock speculation would have an unfavourable effect upon business…" (see Meltzer (2003a), p. 225)) (quoted in Mishkin (2008), p. 4). It was, in fact, the latter's death in 1928 that gave way to a more restrictive monetary policy even though the economic deterioration became evident. This line of policy continued until August 1929 weakening the economy even further, and leading to the stock market crash in October 1929 (Mishkin (2008), p. 4).

an extreme rise in real interest rates and further depressed growth (Mishkin (2008), p. 4).

A second well-documented example is the asset-price bubble in Japan during the 1980s[123], when soaring land and equity prices, in addition to relatively low interest rates substantially encouraged the financing of investment[124]. As pointed out by Mishkin (2008), “Japan's experience re-emphasizes the importance of regulatory policies that may prevent feedback loops between asset price bubbles and credit provision” (Mishkin (2008), p. 5), while Ito and Mishkin (2006) argue that after the bubble burst it was the slow response of the Bank of Japan to the deteriorating economic outlook and the falling inflation that triggered deflation[125].

Theoretical and empirical research has proposed several models explaining why bubbles form, and which also provide an understanding of their implications for policy. For example, Posen (2003) analyses the Japanese experience after the 1980s bubble. He provides cross-country evidence that asset-price booms do not necessarily follow periods of easy monetary policy, and also that sustained monetary policy ease does not always result in booms in asset prices. He, additionally, assesses the

[123] Undoubtedly, during that period Japan was experiencing low unemployment, low inflation and high growth, while it operated a highly efficient business model. During that decade the rise in equity prices exceeded 600 percent, while the increase in land prices exceeded 400 percent (Mishking (2008), p. 5).

[124] The stance of monetary policy was relatively easy during the mid-1980s as the Bank of Japan attempted to contain the rapid appreciation of the yen following the Plaza Accord of 1985 and stimulated domestic demand to correct external imbalances. There was a surge in the ratio of bank loans to gross domestic product, and investment spending became the main driver of economic activity. Due to financial deregulation, there was in increase in banks’ risk-taking behaviour because they channelled more funds to real-estate-related sectors and to small firms, accepting property as collateral. Corporate restrictions on funding in the securities market were lifted in the 1980s, which reduced large firms' reliance on banks' loans. Moreover, interest rate ceilings on bank deposits were also gradually removed. See Okina, Shirakawa, and Shiratsuka (2001).

[125] On this account, Mishkin (2008) highlights the slowness with which the imbalances in Japan's banking sector were addressed as another important factor leading to the weakening of the economy and deflation after the bubble burst (Mishkin (2008), p. 5).

monetary policy in Japan during the boom phase and concludes that poor financial sector practices[126] rather than monetary policy had the defining impact on the bubble. Finally, his analysis shows that (CPI) deflation has not historically followed plummeting asset prices, and he does not find proof of the opposite either. In the face of this result and the fact that for a short period after the bursting of the Japanese bubble inflation was positive and the economy was in a modest recession, Posen (2003) concludes that even though Japan's 'Great Recession' was not inevitable, it was the policy mistakes (taking place in the mid 1990s), as well as inherent financial sector weaknesses that mainly contributed to it.

Moreover, Cochrane (2003) studies the price movements of NASDAQ technology stocks in the 1990s using a model of 'rational behaviour with friction', and advocates that the variation in these stock prices can be explained by a "convenience yield" referring to the velocity of trading and the availability of information. In particular, he argues that the demand for such stocks, even though their prices exceeded their 'fundamental values', resembled the transactions demand for money rather than irrational beliefs about their future course. People were willing to hold shares of a certain stock for a short period, so as to enable short-term trading (which was intense during the boom-phase), despite knowing that the shares were overvalued. Due to market frictions, betting on the future of a company requires owning its stock. A firm's shortage of shares outstanding gave it the "convenience yield". When shares outstanding were substantially increased (due e.g. to initial public offerings, or

[126] Indeed, Mishkin (2008) remarks that "during the boom, Japanese regulations that allowed banks to count as capital unrealized gains from equities may have contributed to banks' appetite for equities during the stock market run-up and to financial instability as the stock market collapsed… After the bursting of the bubble, policymakers did not quickly resolve the fragility of the banking sector, thereby allowing conditions to worsen as banks kept lending to inefficient, debt-ridden, so-called zombie firms" (Mishkin (2008), p. 5).

expiration of ‘lock-up’ periods), the transaction value decreased, leading to a fall in the share price (Cochrane (2003), p. 175-176). His model suggests that policymakers need to improve their information in terms of quantity and quality, as well as transparency and that it is difficult to identify ex ante boom and bust cycles in asset prices.

Furthermore, Eichengreen and Tong (2003) estimate the volatility in equity prices using data from 12 countries spanning over more than a century. They study the link between equity market volatility and its underlying determinants, as, for example, monetary volatility, capital account openness, and the choice of an exchange-rate regime, and find the first of the three possible determinants to be the most important, which shows a positive correlation to equity-price volatility roughly in every country in the sample. The implication is that the ‘unstable’ monetary policy stance during the ‘Great Depression’, as well as the 1970s and 1980s may have contributed to the observed higher equity-price volatility of the time. Therefore, they reach the conclusion that shifts to more stable monetary regimes (inflation-targeting regimes given as an example) may have lead to the reduced volatility in asset prices.

De Bondt (2003) assesses the motivations driving the behaviour of individual investors and argues that Individuals derive knowledge, from experience, logic, and authority, which is applied to mental frameworks resulting in rather predictable patterns of behaviour. Renaud (2003), nevertheless, recognises that such behavioural models are rather difficult to test empirically, while they tend to disregard the dominance of institutional investors in the markets, since they tend to possess better information and professional skills than individual investors, and also have access to more sophisticated risk-management methods. DeBondt (2003) analyses the causes of predictable momentum and reversals in stock prices, where the most possible explanation given is that analysts and traders simply extrapolate past earnings trends. Modern finance has responded to these facts in different ways as it either reinterprets them as non-anomalous (for example, the abnormal profits compensate for time-varying risk), it questions their pervasiveness and robustness (see, for example, Fama (1998)), or it argues that markets may yet be minimally rational, in the sense that markets fail to supply opportunities for abnormal profits. The most common counterargument is the presence of rational arbitrage, according to which is advocated that "even if we accept the notion that many investors misinterpret the news, a relatively few individuals sensitive to arbitrage may make markets work as the standard theory predicts" [quoted in DeBondt (2003), p. 211][127]. According to DeBondt (2003), however, "there are no compelling reasons to give that argument decisive weight" (DeBondt (2003), p. 211).

One way to think about the matter that DeBondt (2003) proposes is to ask for the minimal set of restrictions on heterogeneous beliefs and information sets that even in frictionless markets are necessary for the existence of rational, arbitrage-free equilibrium prices. Rusell and Thaler (1985) and others show that investors are not allowed to form different opinions based on the same substantive information. They must agree on the value implications of any conceivable state. When there is such divergence of opinion, rational prices may yet prevail if at some future time, the true mapping of events into value is revealed to all and if, in the meantime, only rational investors sell short. He views neither of these assumptions to apply to the stock market, while institutional factors, such as sales constraints or capital-gain taxes, are

[127] For a detailed discussion on this point see Brunnermeier (2001).

likely to change the situation for the worse rather than for the better. In a world with nontrivial trading costs and heterogeneous beliefs, every individual not only chooses the size of his holdings in each asset but also in which assets to invest. Equilibrium involves the simultaneous determination of asset prices and the identity of investors trading in each asset. Some economic agents never reveal their information via trade, except by abstaining. As a result, market prices cannot reflect it (see Mayshar (1983)) [128] (De Bondt (2003), p. 211).

Therefore, in an effort to identify the common behavioural elements in the various interpretations of asset price bubbles, Kindleberger's (1978) scenario of a (typical) financial crisis seems useful. In the beginning of the crisis three stages are distinguished, an economic shock that reflects structural change outside the experience of most people and that objectively justifies higher prices (a "new era"), rising investor confidence, leading to the increased use of leverage and speculative instruments, and, finally, a herding effect, where demand increases because prices are increasing. Similarly when the bubble bursts, an outside shock first reduces demand. Next prices drop more as demand slows because even lower prices are expected in the future. The central puzzle is the excessive optimism and overconfidence that start the cycle, as well as the positive feedback trading that keeps it going. After the success stories have become widely known and accepted by the

[128] A pure arbitrage opportunity does not exist unless it is certain that share prices will eventually revert to their fundamental underlying values. However, to affect prices, investors with superior forecasting ability or with inside information must assume increasing amounts of diversifiable risk. In practice, arbitrageurs face financial constraints (Shleifer and Vishny (1997)). Second, it may be rational for these traders to ride the trend rather than to go against it. Third, the resilience of a bubble may stem from the inability of rational arbitrageurs to coordinate their selling strategies (see Abreu and Brunnermeier (2003)). Fourth, a market may rationally launch itself onto a speculative bubble with prices being driven by an arbitrary self-confirming element in expectations (Tirole (1982)). However, DeBondt (2003) states that there is no choice-theoretic rationale for singling out equilibrium price paths that do not suffer this extrinsic uncertainty (De Bondt (2003), p. 211).

pubic, unrealistic hopes for rapid wealth accumulation draw many newcomers into the market. These players tend to naively duplicate strategies that produced high profits in the past. An interesting aspect of herding behaviour is the "illusion of universal liquidity", that is, the belief of any individual trader that in a downturn he will be able to get out while others take losses[129],[130] (DeBondt (2003), p. 212).

Another account to consider is Herring and Wachter (2003) who show that real-estate prices exercise different behaviour than other asset prices. Their model gives explanations of the intense cycles of that market[131], as well as the possible reasons justifying the banks' exposure to such increasing degree of risk. These reasons are perverse incentives (high leverage, implicit insurance, herd behaviour, principal-agent conflicts), disaster myopia, poor data, short-term entry of players, and inadequate analysis. Their analysis recommends that monetary policymakers should fail to encourage a rapid expansion of credit and that financial regulatory policies are necessary in order to restrict the seemingly irrational, but potentially hazardous risk-taking behaviour in asset markets (real-estate market).

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[129] One interpretation of this behaviour is excessive risk-taking or recklessness. Knight (1921) emphasizes, however, that the risk does "not relate to objective external probabilities, but to the value of judgment and executive powers of the person taking the chance ... Most men have an irrationally high confidence in their own good fortune, and that is doubly true when their personal prowess comes into the reckoning ... To these considerations must be added the stimulus of the competitive situation, constantly exerting pressure to outbid one's rivals ... Another ... factor is the human trait of tenacity ... once committed, ... the general rule is to hold on to the last ditch," (pp. 365-366).

[130] Surveying bubbles from the 17th century to the 1987 crash, White (1990)) concludes: "The principal factor that leads to [their] emergence … is that the … fundamentals of assets … cease to be well identified. Another feature … is the appearance of … inexperienced investors" [quoted in DeBondt (2003), p. 212]. Shiller (2000) also defends the feedback theory. He ascribes a prominent role to the mass media in the Internet bubble. Evidently, many other self-interested parties (top managers, auditors, investment bankers, analysts, brokers, lawyers, and politicians) stoked the fire (DeBondt (2003), p. 212).

[131] The cycle they, in fact, describe, refers to bank-dominated financial systems. In particular, bank credit issued to the real-estate sector expands rapidly and the value of real estate prices increases, in turn. The higher prices raise the perceived collateral-value of these assets to banks, which lowers the 'perception of risk' banks' hold for that market, therefore motivating them to issue more loans, at greater risk and at a lower cost to the borrowers.

Bordo and Wheelock (2004) study stock-market booms in the US over 200 years and conclude that two seem to be the most important in terms of their length and rate of increase in market prices, the booms of 1923-29 and 1994-2000. They focus, first, on the role of asset prices in the monetary policy transmission, which, in fact, refers to the extent to which monetary policy may trigger an asset price boom, and, second, the appropriate response of monetary policy to asset price booms, which addresses the cases when monetary policymakers should attempt to defuse asset price booms. Their general conclusions are that "booms occurred in periods of rapid real growth and advances in productivity" and that "there is no consistent relationship between inflation and stock market booms, though booms have typically occurred when money and credit growth were above average" [132] (Bordo and Wheelock (2004), p. 19).

### 5.4 Recent Experience with Asset Price Bubbles

The prolonged build-ups and sharp declines in asset prices in many markets (such as equity and housing markets) have been a distinctive feature in the last thirty years in both industrialized and developing countries, with serious adverse consequences for the macroeconomies of these countries. Such events have given rise to an intense debate in academic and policy circles (that has been intensified even further during the last two years in the event of the global financial and economic turmoil) in the effort to identify the appropriate monetary and regulatory response to such dramatic shifts. Identifying and analyzing lessons from this volatility that could be used to

[132] For the link between inflation and stock-market booms see, also, Boyd, Levine and Smith (2001).

prevent, or, at least, mitigate the magnitude of future financial crises has been of prime importance to the international community. In the aftermath of the credit crunches that took place in major industrialised economies in the last two years and the consequent economic turbulence, policymakers feel the urge not only to define and implement the best fitting remedial action, but also to gain insights about the varied causes and identify lessons from the relevant consequences of the events under consideration.

Initially, as pointed out by Bean (2004), if asset price bubbles affected the economy only through conventional wealth effects on aggregate demand, monetary policymakers would not face a great difficulty in their effort to find the appropriate response. As changes in wealth affect consumer spending with lags similar to those necessary to feed changes in interest rates to consumer spending, if the impact of asset price booms and busts were via wealth effects on aggregate demand, monetary policy would be able to offset such impact. Therefore, he recognises that it is the broader set of symptoms that asset price bubbles tend to be associated with, which need to be addressed in each case by monetary policymakers (Bean (2004), p. 14). In addition to Bean (2004), Bordo and Jeanne (2002b), for example, as well as Borio and Lowe (2003), note that such symptoms typically include high investment and a built-up of debt.

An asset price bubble may be triggered by a positive supply shock. Asset values may appreciate due to excessive optimism about future returns, which, in turn, increases borrowing to finance further accumulation of capital. The higher asset values leads to higher collateral values and, thus, encourages debt accumulation. In the boom phase, balance-sheet positions give no signs of deterioration since debt accumulation is covered by the appreciation in asset values. These signs are projected when the bubble bursts, leading to acute deterioration in the borrowers' net worth and a tightening in credit conditions, possibly to the extent of a credit crunch. Bean (2004) remarks that "such a credit crunch is likely to impact on activity more quickly than a conventional wealth effect and, moreover, temporarily reduce the effectiveness of monetary policy. Neutralizing the macroeconomic consequences of such financial instability may, thus, be difficult to achieve"[133] (Bean (2004), p. 14).

Furthermore, Hunter, Kaufmann and Pomerleano (2003) note that even though gains and losses generated by asset price bubbles are well documented, research does not give definitive answers as to their causes and characteristics, let alone their typical behaviour. They contend that "by unravelling the factors that lead to and amplify asset bubbles, explanations can be given on why some bubbles result in greater, more prolonged losses and what policymakers can do to safeguard economies from these costly, destabilizing episodes" (Hunter, Kaufmann and Pomerleano (2003), p. xiii).

In this respect, Allen and Gale (2000) study 'positive' and 'negative' asset price bubbles, and analyse their relationship to monetary policy. They identify the presence of positive bubbles when there is an 'agency problem' between banks and their borrowers stemming from the banks' inherent inability to observe how the funds are invested. The agency problem refers to investors' choosing riskier projects than they normally would, thus, bidding-up the relevant prices. In this way, asset prices may exceed their fundamental values. In this case, the greater the risk assumed

[133] Bean (2004) points out the difficulty in devising an appropriate response also because he disapproves of the use of an augmented Taylor-type rule as a proposed solution.

the more the bubble may inflate[134]. Allen and Gale (2000) notably remark that “it is not only the risk that is associated with real asset returns that can cause a bubble but also the financial risk associated with the uncertainties of monetary policy and particularly financial liberalisation. … The conclusion is that the central bank should keep such uncertainties to a minimum. The less is the uncertainty, the less the magnitude of the positive bubble will be” (Allen and Gale (2000), p. 26).

Conversely, negative bubbles may be triggered by a banking crisis that leads banks to simultaneously liquidate assets. In this event, asset prices fall below their fundamental value due to a shortage of liquidity. Since this type of bubble can be very detrimental to the economy, they recognise that the central bank needs to interfere so as to restrain the downwards movement in asset prices by injecting liquidity, as well as by lending against the banks’ assets. In this respect they note that “the central bank has a complicated task to prevent both types of bubble” and that “it is important for it to correctly identify which is the relevant problem and the appropriate policy to solve it otherwise the situation will only be exacerbated” (Allen and Gale (2000), p. 26).

Simon (2003) asserts that a bubble is an asset-market event where prices rise, potentially with justification, rise further on the back of speculation, and then fall dramatically for no clear reason when the speculation collapses. Furthermore, he also contends that they typically occur in an environment of general optimism, for example, at the end of a long expansion. Commonly associated with these price changes, but not necessarily, are an easy availability of credit, new technology, and an increase in company formation (Simon (2003), p. 18).

[134] See also Richards and Robinson eds. (2003).

Within the bubble literature there is a branch that deals with the possibility that bubbles could be perfectly rational (an early influential account is Blanchard and Watson (1982)). This theory proposes that people are fully aware that the market has departed from fundamentals but still invest because the profits from being in the bubble outweigh the risk associated with it bursting. In addition, there are further accounts that bubbles in fact stem from fundamental changes, which, in essence, implies that there are no true bubbles (see, for example, LeRoy (2004) for a discussion). If any of the above were the true scenario, then there is less force to arguments that action of some sort (be in terms of monetary policy or prudential regulation) is required. If that were the case, then people are fully informed and are behaving rationally. White (1990) summarises this point in the following: “If stock-market bubbles are, for the most part, a reflection and reaction to underlying changes in the economy, then the correct policy is simply to let them run their course, however distressing this may be to individual investors” (White (1990), p. 240).

Simon (2003) examines three asset-price bubbles in Australia, than were considerably different in type[135], and shows that regardless of whether they were ‘rational’ or fundamentally based, or not they had significant consequences. He thus concludes that “in this respect, it is not crucial whether bubbles are rational or fundamentally based, but the fact that they have significant consequences is reason enough for policymakers to be concerned” (Simon (2003), p. 38).

Other regional experiences give historical perspectives on the development of asset-price bubbles, as well as the types of policy environments that resulted in

[135] These Australian bubbles are namely the land bubble in Melbourne in the 1880s, the Poseidon nickel bubble of 1969-1970, and the stock and property market bubbles of the late 1980s.

exaggerating or mitigating the impact of collapses. Mishkin and White (2003) study 15 episodes of U.S. stock-market crashes during the last century and provide a classification with respect to their impact to the financial system[136].

Mishkin and White (2003) suggest that "because stock-market crashes are often not followed by signs of financial instability, we must always be cautious about assigning causality from timing evidence, while certainly, one cannot make the case that stock-market crashes are the main cause of financial instability" (Mishkin and White (2003), p. 73). In fact, in several such episodes it is argued that the source of financial instability might have been caused by other factors, such as the collapse of the banking system or the severity of the economic contraction[137]. The theory of how stock-market crashes can interfere with the efficient functioning of financial markets

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[136] According to Mishkin and White (2003), this classification can be in the following four categories:

(i) Episodes where the stock-market crashes did not appear to stress the financial system because interest-rate spreads did not widen substantially. These include the crashes of 1903, 1940, 1946, 1962, and 2000. (ii) Episodes in which the crashes were extremely sharp and which put stress on the financial system, but where there was little widening of spreads subsequently because of intervention by the Federal Reserve so as to maintain the functioning of the financial system. These include the crashes of 1929 and 1987. (iii) Episodes in which the crashes were associated with large increases in spreads suggesting severe financial distress. These include the crashes of 1907, 1930-33, 1937, and 1973-74. (iv) Episodes in which the crashes were associated with increases in spreads that were not as large as in the third category, suggesting some financial distress. These include the crashes of 1917, 1920, 1969-70, and 1990.

They view that deciding which crashes go into categories 3 and 4 is somewhat arbitrary, and draw the following general conclusions: "First is the fact that many stock market crashes (category 1) are not accompanied by increases in spreads, which suggests that stock-market crashes by themselves do not necessarily produce financial instability. These episodes also are ones in which the balance sheets and the financial system are in good shape before the onset of the stock-market crash. Furthermore, in these cases where financial instability does not appear, economic downturns tend to be fairly mild. Second, very sharp stock-market crashes like those in 1929 and 1987 (category 2) do have the potential to disrupt financial markets. But actions by the central bank to prevent crashes from seizing up markets – not to prop up stock prices are able to prevent financial instability from spinning out of control. Third, situations in which financial instability becomes severe, when spreads widen substantially (category 3), are associated with the worst economic downturn" (Mishkin and White (2003), p. 72-73).

[137] Mishkin and White (2003) give more direct evidence that some financial markets were unable to function as a result of the stock-market crash only in the cases of the extremely sharp market crashes in 1929 and 1987 (Mishkin and White (2003), p. 73).

suggests that the impact of a stock market crash will be very different depending on the initial conditions of balance sheets in the economy.

Therefore, the monetary policy implications of their analysis of the stock market crashes are as follows. The first is that the major issue of concern to policymakers is not stock-market crashes but financial instability, irrespective of the fact that the former may reflect the unwinding of an asset-price bubble. If the balance sheets of financial and non-financial institutions are initially strong, then a stock market crash (bursting of the bubble) is unlikely to lead to financial instability. In this case, the effect of a stock market crash on the economy will operate through the usual wealth and cost of capital channels, only requiring the monetary policymakers to respond to the standard effects of the stock market decline on aggregate demand. In this situation, optimal monetary policy, which focuses solely on minimising a standard loss function, will not respond to the stock market decline over and above its effects on inflation and output (Mishkin and White (2003), p. 74). Indeed, a regime of flexible inflation targeting, which, according to Bernanke, Laubach, Mishkin, and Posen (1999), is in essence what all inflation-targeters actually pursue, is consistent with this type of optimal monetary policy (Svensson, 1997). Also Bernanke and Gertler (1999) have shown that a regime of flexible inflation targeting is likely to make financial instability less likely and to be stabilizing in the presence of asset price bubbles.

However, Mishkin and White (2003) contend that central banks may see the need to directly respond to a stock market crash when the crash puts stress on the financial system in order to prevent financial instability. We have seen exactly this response of the Fed in the crashes of 1929 and 1987, when the Fed had direct evidence that financial markets were unable to function in the immediate aftermath of the crashes. What is important about both these two episodes is the nature of the stress on financial markets. The source of stress had more to do with the speed of the stock market decline than the overall decline of the market over time, which has often been far larger with little impact on the financial system. Furthermore, in both episodes, the focus of the Federal Reserve was not to try to prop up stock prices but, rather, to make sure that the financial markets, which were starting to seize up, would begin functioning normally again (Mishkin and White (2003), p. 75).

A focus on financial instability also implies that central banks will respond to disruptions in financial market is not a major concern[138]. Because of the disruption to the payments system, the liquidity needs of the financial system skyrocketed. To satisfy theses needs and keep the financial system from seizing up, within a few hours of the incident, the Fed made a similar announcement to that made after the crash of 1987, stating, "The Federal Reserve System is open and operating. The

[138] For example, as described in Mishkin (1991), Brimmer (1989), and Maisel (1973), the U.S. Federal Reserve responded aggressively to prevent a financial crisis after the Penn-Central bankruptcy in June 1970 without much concern for developments in the stock market even though the market had an appreciable decline from its peak in late 1968. In the aftermath of the Penn-Central bankruptcy, the commercial paper market stopped functioning and the Federal Reserve exercised a lender-of-last-resort operation. The New York Fed got in touch with money centre banks, encouraged them to lend to their customers who were unable to roll over their commercial paper, and indicated that the discount window would be made available to the banks so that they could make these loans. These banks then followed the Fed's suggestion and received $575 million through the discount window for this purpose. In addition, the Fed, along with the Federal Deposit Insurance Corporation and the Federal Home Loan banks decided to suspend regulation Q ceilings and the Fed supplied liquidity to the banks through open market operations. Similarly, in the fall of 1998, the Fed supplied liquidity to the system and lowered the federal funds rate sharply by 75 basis points even when the market was at levels that were considered to be very high by Federal Reserve officials. The Fed's intervention stemmed from its concerns about the stress put on the financial system by the Russian crisis and the failure of Long-Term Capital Management. A spectacular lender-of-last-resort operation was also carried out in the aftermath of the destruction of the World Trade Centre on September 11, 2001 (Mishkin and White (2003) p. 74).

discount window is available to meet liquidity needs"[139],[140] (Mishkin and White (2003), p. 75).

These examples in Mishkin and White (2003) suggest the importance of having a central bank focus on the potential of financial instability per se. Too much of a focus on the stock market rather than on the potential for financial instability may lead central banks to fail to take appropriate actions as in 1970, 1998, and 2001, when the level of the stock market was not a primary concern. Too great a focus on the stock market also presents other dangers for central banks. Too much attention on asset prices (in Mishkin and White's (2003) case common stock) can lead to the wrong policy responses. The optimal response to a change in asset prices very much depends on the source of the shock to these prices and the duration of the shock[141].

A second problem with the central bank focusing too much on stock prices is that it raises the possibility that the central bank will be made to look foolish. The linkage between monetary policy and stock prices, although an important part of the transmission mechanism, is still, nevertheless, a week one. Most fluctuations in stock prices occur for reasons unrelated to monetary policy, either reflecting real

[139] "Economic Front: How Policy Makers Regrouped to Defend the Financial System", *The Wall Street Journal*, Tuesday, September 18, 2001, p. A1.

[140] The Fed then proceeded to provide 45$ billion to banks through the discount window, a 200-fold increase over the previous week. When the stock market reopened on Monday, September 17, trading was orderly, although the Dow Jones average did decline by more than 7 percent (Mishkin and White (2003) p. 75).

[141] It is worth mentioning the very useful example of this pitfall of too much focus on an asset price given by Mishkin and White (2003), which is the tightening of monetary policy in Chile and New Zealand in response to the downward pressure on the exchange rate of their currencies in the aftermath of the East Asian and Russian crises in 1997 and 1998 (see Mishkin and Schmidt-Hebbel, 2002). Given that the shock to the exchange rate was a negative terms of trade shock, it would have better been met by an easing of policy rather than a tightening. Indeed, the Reserve Bank of Australia responded in the opposite direction to the central banks of New Zealand and Chile, and eased monetary policy after the collapse of the Thai baht in July 1997 because it was focused on inflation control and not the exchange rate. The excellent performance of the Australian economy relative to New Zealand and Chile's during this period illustrates the benefit of focusing on the main objective of the central bank rather than on the asset price (Mishkin and White (2003) p. 75).

fundamentals or animal spirits. The loose link between monetary policy and stock prices, therefore, means that the ability of the central bank to control stock prices is very limited. Thus, if the central bank indicates that it wants stock prices to change in a particular direction, it is likely to find that stock prices may move in the opposite direction, thus making the central bank look inept (Mishkin and White (2003), p. 75).

A third problem with focusing on stock (or equivalently asset) prices is that it may make central banks seems as if they try to control a relatively vast amount of elements of the economy. Mishkin and White (2003) stress that the success in central banking practices during the 'Great Moderation' times is partly attributed to the fact that "they have narrowed their focus and have more actively communicated what they can and cannot do, … [that] specifically, [they] have argued that they are less capable of managing short-run business cycle fluctuation and should, therefore, focus more on price stability their primary goal" (Mishkin and White (2003), p. 76)[142]. In this way, in their effort to become independent they managed to gain public support. They, therefore, conclude in this matter that "extending their focus to asset prices has the potential to weaken public support for central banks and may even cause the public to worry that the central bank is too powerful, having undue influence over all aspects of the economy" (Mishkin and White (2003), p. 76).

The fourth and final problem with too much focus on the stock market that Mishkin and White (2003) identify is that such focus may create a form of moral hazard. Knowing that the central bank is likely to support the stock market if it crashes, the markets are then more likely to bid up stock prices. This might help facilitate

[142] Bernanke, Laubach, Mishkin, and Posen (1999), for example argue that a main element of the success of the Bundesbank's monetary targeting regime was that it did not focus on short-run output fluctuations in setting monetary policy instruments.

excessive valuation of stocks and help encourage a stock market bubble that might crash later, something that the central bank would rather avoid. If the central bank has no informational advantage, if it knows that a bubble has developed that will eventually crash, then the market knows this too. The bubble would, then, unravel and, thus, it would be unlikely to develop. Without an informational advantage, the central bank is as likely to mis-predict the presence of a bubble as the private market and, thus, will frequently be mistaken, thus, frequently pursuing the wrong monetary policy (Mishkin and White (2003), p. 76).

A main conclusion of Mishkin and White (2003) is that the key problem facing monetary policymakers is not stock market crashes and the possible bursting of a bubble, but rather whether serious financial instability is present. They contend that "with a focus on financial stability rather than the stock market, the response of central banks to stock market fluctuations is more likely to be optimal and, therefore, support for the independence of the central bank can be maintained" (Mishkin and White (2003), p. 76). Their analysis also supports the general conclusion that it is considerably difficult for a central bank (let alone market participants) to identify the presence of a bubble ex ante.

Similar conclusions can also be drawn from the unwinding of the asset-price bubble in Japan during the late 1980s, irrespective of the inherent differences. Okina and Shiratsuka (2003) examine the policies that the Bank of Japan implemented in the late 1980s after the collapse in asset prices triggered the economic downturn that spanned over more than a decade[143]. A basic conclusion in their analysis is against

[143] Okina and Shiratsuka (2003) evaluate the criticisms over monetary policy in Japan at the time, which have commonly been those of excessive monetary easing during the late 1980s, as well as a delay in monetary tightening. In addition, they recognize that it is considerably difficult for

asset-price targeting because policymakers cannot extract sufficient information from asset prices so as to make 'real-time judgments about future growth'. In this manner they conclude that 'flexible interest-rate targeting' may not be the correct guide for monetary policy and they recognise the need for alternatives. They assess that unlike, for example, the U.S. 'tech-stock bubble', the unwinding of the asset price bubble in Japan resulted in a long-term economic downturn, which was further cultivated by the fragility of the financial system. In the Japanese bank-based financial system, banks did not fail from lending to unprofitable firms in order to restrain further losses. However, bank capital was eventually eroded by failing firms, thus, rendering financial institutions unable to assume risks, which resulted in a credit crunch. Therefore, monetary policy easing was ineffective, and, in fact, monetary policy effectiveness was further hampered by the inability to issue new loans.

In addition, Okina, Shirakawa and Shiratsuka (2001) argue that monetary policy is incapable of controlling the level of asset prices. They view that if this were the case, monetary policy would only result in amplifying economic fluctuations. However, they accept that asset prices influence monetary policy in several ways, such as influencing expenditures via wealth effects, or reflecting valuable information about expectations with respect to the future economic outlook. In particular they remark that if monetary policy extracts useful information from asset prices, it should not fail to recognise that asset-price changes not only reflect private expectations for inflation, but also other issues like phenomena similar to the bubble as well as

policymakers to identify bubbles in early stages of their development. They view that several models assessing inflation and output gap in Japan during the late 1980s suggest conflicting policy responses which are, in fact, dependent on the underlying assumptions and the modelling choices, such as how to evaluate the fundamental value of asset prices and inflationary pressures, how to decompose the rising growth rate into cyclical and trend components, and how to identify the correct path for potential growth.

structural changes in the economy[144]. They, finally, argue that changes in asset prices may hugely affect the financial system stability and, in due course, overall economic activity (Okina, Shirakawa and Shiratsuka (2001), p. 446).

They also accept that it is vital for central banks to analyse asset price changes and evaluate the expectations that they reflect, in particular, whether, in view of the above conclusions, the latter are sustainable with the course of the economy as a whole. For example, during the boom phase of a bubble, money supply and credit tend to expand. However, they view that judgement on whether such expansion is compatible with sustainable economic growth cannot be made only by monitoring the growth rates of the money supply and credit. Okina, Shirakawa and Shiratsuka (2001) draw a final conclusion that points towards the necessity of designing an appropriate institutional framework, since "monetary policy influences the decisions and behaviour of private economic agents through interest rates and liquidity, but the degree of influence depends on the institutional framework, such as the supervision of financial institutions, taxation, the regulatory framework, accounting system, and legal infrastructure"[145] (Okina, Shirakawa and Shiratsuka (2001), p. 447).

Furthermore, Saito and Shiratsuka (2001) study the case when liquidity constraints due to realised adverse shocks force financial institutions (institutional investors and

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[144] They recognise that useful information may, for example, be extracted from the derivatives and other financial markets as e.g. examined in Nakamura and Shiratsuka (1999).

[145] Referring to the Japanese bubble period and following this line of reasoning Okina, Shirakawa and Shiratsuka (2003) state the following: "If financial deregulation had progressed at an earlier stage, and if the regulatory and supervisory framework had been modified in line with the changes in financial markets, the behaviour of financial institutions would probably have been different to some extent. If taxation on land had not been biased toward accelerating an increase in land prices, the degree of increase in land prices would have been different. If the Bank of Japan had implemented reform measures with respect to the short-term money market and window guidance at an earlier stage, economic developments might have been slightly better" (Okina, Shirakawa and Shiratsuka (2001), p. 448).

intermediaries) to quit normally profitable financial practices, such as profitable investment opportunities, efficient market-making, and gainful arbitrage opportunities. This liquidity constraint may lead to a huge negative effect on asset pricing, and eventually dynamic-resource allocation (Saito and Shiratsuka (2001), p. 255).

Saito and Shiratsuka (2001) accept that borrowers' liquidity constraints stem at least partially from the asymmetry of information between borrowers and lenders. As analysed in Williamson (1987), extending Townsend (1979), the optimality of a simple debt contract rests on lenders' inability to observe internal cash flows. As a result creditors charge a credit premium on such loan contracts as a compensation for default risk. Large credit premia might not be enough compensation for default risk, in the case of borrowers' relying heavily on this form of outside financing. In addition, if the latter is the case outside lenders show a great reluctance to provide funds to such borrowers. This results in, for example, adverse technological shocks lowering profits and rendering firms even more dependent on outside financing, increasing the possibility of these firms to experience liquidity constraints. Apparently, a severe liquidity constraint imposes an immediate negative effect on corporate spending activity (Saito and Shiratsuka (2001), p. 257). The macroeconomic literature on credit channels gives a thorough analysis on this account (see for example Bernanke and Gertler (1995), Kiyotaki and Moore (1997), Shleifer and Vishny (1992)).

In the event of a financial crisis, financially-stressed financial institutions (commercial banks in their analysis) tend to face substantial difficulties with lending, arbitraging, and dealing. Consequently, policy-targeted interest rates or interbank overnight rates may fail to be transmitted to other longer-term interest rates. Saito and Shiratsuka (2001), therefore, argue that "it is important for a central bank to intervene in various financial markets to fix segmented markets, thereby recovering market liquidity and restoring the proper transmission mechanism. In that sense, the monetary operation motivated by the above consideration … should require not only the expansion of the aggregate amount of liquidity available in money markets through lowering short-term interest rates, but also the control of the allocation of liquidity among financial markets, thereby transmitting the policy-targeted short-term interest rate to the returns on other financial instruments" (Saito and Shiratsuka (2001), p. 266).

Furthermore, Collyns and Senhadji (2003) study the East Asia financial crisis during 1997, and assess that excessive optimism resulted in large inflows of capital in several countries in the area, as well as in a rapid increase in domestic credit issued by an "under-regulated banking system", and vast amounts of investment in property. The eventual reversal of the process with successive outflows of capital triggered excessive pessimism, investor flight, bank failures, and a collapse of the equity, housing, and debt markets. In addition to the effect the crisis had on the financial markets, real wages also plummeted, and unemployment rose to very high levels. Remarkably, rural credit evaporated and even becoming life-threatening.

Collyns and Senhadji (2003) find that prior to the crisis the countries in East Asia demonstrated a close relationship between the under-estimation of risk, excessive optimism and increasing supply of credit (the real estate sector being the most prominent case), with the asset price inflation that followed. In particular, the real estate sector is a dramatic illustration of this cycle, since property values were rapidly increasing, and banks that issued collateral-based loans demonstrated an increasing willingness and capacity to lend. Collyns and Senhadji (2003) point out an "asymmetric response" of property prices to credit, as during periods of increasing real-estate prices such response is three times higher than the one during periods of declining prices. They view such asymmetry mainly as a result of the opaqueness in real estate markets, while they recognise that the unwinding of the bubbles in each country gave rise to varied results[146]. Overall, they conclude that "the Asian experience with property price booms and busts and the consequences for financial stability reinforce the *critical importance of strong bank regulation* [emphasis is in the original], both to reduce risks that a bubble will develop and to contain the disruptive costs when a bubble bursts. In particular, restraining the growth of bank credit to the property and related sectors discourages the development of real estate bubbles (Collyns and Senhadji (2003), p. 123).

Herrera and Perry (2003) express similar issues in Latin America. They study 22 episodes of asset-price bubbles in Latin America during the period between 1980 and 2000, and show that 14 of the 22 episodes ended in crashes. Notably, these crashes lead to regional currency crises. Herrera and Perry (2003), finally, identify a set of common determinants, such as domestic factors including an accelerating expansion in credit and the volatility of credit growth and asset returns, as well as external factors, such as capital-flow changes due to changes in U.S. short-term interest rates.

[146] Collyns and Senhadji (2003) highlight extreme property price cycles have not been a necessary neither a sufficient condition to trigger the subsequent crises that occurred in countries' exchange markets and banks of their sample. For example, Malaysia, Hong Kong SAR, and Singapore survived the real estate fallout and minimized damage to the rest of their economies. They contribute these results to the fact that these countries possessed relatively sound banking regulatory frameworks before the development of the pertinent bubbles and policymakers did not fail to take immediate action to reduce and contain the adverse consequences of the bubbles bursting. Such episodes emphasize how vital strong banking regulation to safeguard a financial system from the damaging consequences that tend to rise after a bubble collapses.

## 5.5 Asset Price Bubbles and the Monetary Transmission Mechanism

Several views have been expressed about how monetary policy may lead to a boom in asset prices. According to Bordo and Wheelock (2004) a 'traditional' approach addresses the response of asset prices to a change in the money supply. According to this approach, added liquidity increases asset demand, therefore leading to an increase in their prices, stimulating, in turn, the economy. Another approach, advocated by Austrian economists during the 1920s and more recently by BIS economists, views a higher possibility of asset price booms arising in a regime of low and stable inflation. In particular, it is argued that monetary policy may encourage asset price booms through a credible stabilisation of the price level. A final approach, expressed in the dynamic general-equilibrium macroeconomics literature, advocates that asset price bubbles can in fact be a result of the failure of monetary policy to credibly stabilise the price level (Bordo and Wheelock (2004), p. 19).

Models of the traditional approach have a long history[147]. According to these models, central bank operations increase liquidity and in this way increase asset prices, which include equity and real estate prices, and consequently lower their returns. As the returns of the relatively more liquid assets decline compared to the less liquid ones the former are substituted for the latter. Expansionary monetary policy will affect the price of short-term government securities, then longer-term securities, then assets such as stocks or real estate, and commodities such as gold. Eventually, the effect will reach the overall price level. Therefore, according to this view rising asset prices

[147] Metlzer (1951), for example, in addition to other early Keynesian IS-LM models, modelled central bank operations to directly affect stock prices. Models that followed, variants of which are presented in Friedman and Schwartz (1963), Tobin (1969), and Brunner and Meltzer (1973), incorporate a broader range of assets into the traditional Keynesian liquidity mechanism (Bordo and Wheelock (2004), p. 20).

constitute a potential indicator of future inflation (Bordo and Wheelock (2004), p. 20).

The proponents of the Austrian view advocate that asset-price booms, irrespective of their fundamental cause, may progress to a bubble central bank inaction that encourages an expansion in bank credit that amplifies the boom. According to this view, a crash will inevitably follow a booming phase bringing forward the potential of a vast economic downturn, unless monetary policymakers try to defuse the boom. The 'Austrian school' economists typically equate increasing asset prices with general price inflation[148].

The recent discussion on asset price booms incorporates elements of the Austrian view. A first refers to the inclusion of asset prices in the price-index targeted by the central bank. A second concerns the issue of "financial imbalances", which Borio and Lowe (2002) define as "rapid growth of credit in conjunction with rapid increases in asset prices and, possible, investment" [149] (Borio and Lowe (2002), p. 7). Borio and Lowe (2002) argue that when such financial imbalances build-up the risk of a financial crisis and macroeconomic instability increases considerably. They point out that low inflation can, in fact, promote financial imbalances, irrespective of the underlying initial cause of a boom in asset prices. They contend that "these endogenous responses to credible monetary policy [can] increase the probability that the latent inflation pressures manifest themselves in the development of imbalances

[148] The Austrians viewed the period in US between 1923 and 1929 as one of rapid inflation amplified by lax monetary policy and excessive bank credit growth even though the level of US consumer prices was virtually unchanged (see Rothbard (1983)). Laidler (2003), (2006) and the references therein give more on the Austrian view.

[149] See also Borio, English and Filardo (2003) and Borio and White (2004).

in the financial system, rather than immediate upward pressure in higher goods and services price inflation" (Borio and Lowe (2002), p. 30-31).

Equilibrium rational expectations models have also studied extensively the likelihood of monetary policy in fact producing asset price bubbles. These models show that poorly designed monetary policies, like the use of an interest-rate rule without commitment to a steady long-run inflation rate, may lead to self-fulfilling prophesies and asset price bubbles. Woodford (2003) argues that these outcomes may not arise if monetary policymakers follow a clear rule in which the interest rate target is adjusted so as to stabilise inflation. Bordo and Wheelock (2004) remark that "the theoretical literature thus suggests that consideration of the monetary policy environment may be crucial to understanding why asset booms come about" (Bordo and Wheelock (2004), p. 21).

## 5.6 Concluding Remarks

Kindleberger (1995) points out there are no rule-of-thumb practices to address asset price misalignments [150]. Bubbles in asset prices feed through wealth effects in household consumption. As perceptions about the future growth of incomes rise, the creditworthiness of households increases, on the one hand, and as the cost of new capital falls affecting in corporate investment, expectations rise about future growth

[150] Kindleberger (1995), in particular, stressed that "when speculation threatens substantial rises in asset prices, with a possible collapse in asset markets later, and a harm to the financial system, or if domestic conditions call for one sort of policy, and international goals for another, monetary authorities confront a dilemma calling for judgement, not cookbook rules of the game. It is, I believe realistic" (Kindleberger (1995), p. 35).

of earnings, and, eventually, greater perceived creditworthiness of firms, on the other hand.

As Hunter, Kaufmann and Pomerleano (2003) note the collective experiences of many countries point towards the similarity in the challenges faced by policymakers around the world. Initially, it is difficult to identify bubbles in an early stage of their development. The possibility that asset price increases are a result of a favourable shift in economic fundamentals always seems tempting to accept. Nevertheless, the information that monetary policymakers have (during the early stages in the development of a bubble) tends to be incomplete and at times ambiguous. Policymakers are also subject to considerable public and political pressures. Second, in most cases, bubbles tend to follow rapid credit expansions. Third, when bubbles burst various outcomes arise in different countries. Notably, countries that have robust financial systems present relatively less systemic distress than countries with weak systems. Fourth, advanced economic development fails to protect an economy from the potential of an asset price collapse. Finally, attempts to prick a bubble may cause more harm than good (Hunter, Kaufman and Pomerleano eds. (2003), p. 17).

The issue, therefore, remains of the appropriate role monetary policy should exert based on these experiences. Yet as Hunter, Kaufmann and Pomerleano (2003) remark it is generally argued that policymakers should strengthen regulatory and prudential policy to reinforce the financial system. Additionally, since credit booms tend to lead to asset bubbles, it is advocated that measures need to be taken so as to contain rapid credit growth (as, for example, higher collateral coverage), restrain the reliance on stocks and real estate collateral for the issuing of loans, and improve credit practices. An emphasis is also given to the introduction of more countercyclical loan-loss provisioning (Hunter, Kaufman and Pomerleano eds. (2003), p. 17).

# CHAPTER 6

# HOW SHOULD MONETARY POLICY RESPOND TO ASSET PRICE BUBBLES?

## 6.1 Introduction

The U.S. stock-market boom during 1994-2000 and the following recession generated an extensive debate over how monetary policy should respond to an asset-price boom, if it is considered appropriate to give any response at all. It is vital to make the distinction that both academics and central banking practitioners agree that in the aftermath of a bursting of a bubble monetary policy needs to be conducted in a way that counters the adverse consequences brought forward. Therefore, the content of this chapter does not address the important issue of how monetary policy can enhance the recovery of an economy that has already fallen into a post-financial-crisis recession, that is currently of major concern to both academics and policymakers in view of the current global financial and economic turmoil.

As financial crises and economic contractions tended historically to follow periods of explosive asset-price growth, it is argued that monetary policy can restrain the adverse effects that financial instability may impose on the economy overall, just by attempting to defuse asset-price booms at a relatively early stage. However, as Bordo and Wheelock (2004) suggest, how likely it is that asset prices eventually collapse leading also to a macroeconomic decline may depend on the underlying reason of their appreciation. It has been proposed that so long as booms in asset prices are justified by fundamental behaviour, such as the presence of realistic prospects for future earnings growth, they do not constitute any threat to the outlook for inflation or overall economic activity. On the contrary, if booming asset prices are evaluated to reflect irrational behaviour, such as excessive optimism about future economic prospects, they may threaten economic stability and, thus, warrant a monetary policy attempt to encourage market participants towards more realistic asset price valuations (Bordo and Wheelock (2004), p. 21).

## 6.2 Monetary Policy Responses

According to the conventional approach a reaction of monetary policy to asset-price misalignments is justified only when the latter are known to provide useful information about the future course of inflation. In particular, so long as monetary policy maintains price stability, it promotes financial stability as well (see, for example, Schwartz (1995) and Bordo, Dueker, and Wheelock (2002), (2003)). This view holds that financial crises (or simply "financial imbalances") need to be tackled by lender-of-last-resort practices or regulatory policies (as in Schwartz (2002))[151]. Bernanke and Gertler (1999) express this view in the following concise way: "The inflation targeting approach dictates that central banks should adjust monetary policy actively and pre-emptively to offset incipient inflationary and deflationary pressures. Importantly, for present purposes, it also implies that policy should *not* respond to

[151] This approach is famously proposed in Bernanke and Gertler (1999), (2001) in the context of a Taylor rule, as well as among others in Schinasi and Hargraves (1993), Bullard and Schaling (2002), and White (2004).

changes in asset prices, except insofar as they signal changes in expected inflation" [emphasis is in the original] (Bernanke and Gertler (1999), p. 78).

The conventional approach, however, has been (at least partially) criticised by several economists. For example, according to Smets (1997) in the presence of 'irrational exuberance' in the financial markets a monetary policy tightening is actually optimal. In a similar manner, Cecchetti, Genberg, Lipsky, and Wadhwani (2000) suggest a monetary policy reaction to asset-price misalignments. However, Bernanke and Gertler (2001) doubt whether policymakers are in fact capable of reliable judgement of whether asset price movements reflect "irrational exuberance" or that the possibility of a collapse in asset prices is substantial and imminent. Nevertheless, on this account, Cecchetti (2003) argues that the task of identifying promptly and accurately asset-price misalignments is not more challenging than other elements of policy-design, such as potential output.

Bordo and Jeanne (2002a), (2002b) are in favour of a monetary policy reaction to asset price booms, as they view that pre-emptive actions so as to contain asset-price misalignments, in fact, provide insurance against the high economy-wide costs of lost output in the event of the bubble bursting. They argue that policymakers must try to defuse asset-price booms either when there is a high risk of a bust (and the consequences it may bring considerably damaging to the economy) or when the cost of such an attempt is estimated to be low in terms of foregone output. They point-out that the more optimistic investors get, the higher the risk of a market-sentiment reversal becomes. However, a higher cost is attached to monetary policy actions of 'leaning against the wind of investor optimism'. Therefore, they contend that monetary policymakers need to evaluate not only the probability of a crisis occurring, but also the extent to which monetary policy is capable of reducing this probability.

Greenspan famously saw a conundrum in the attempts of monetary policymakers to defuse an asset-price boom. He argued that the likelihood of stock-market booms occurring is relatively high in low inflation environments:

> "…We have a very great difficulty in monetary policy when we confront stock market bubbles. That is because, to the extent that we are successful in keeping product price inflation down, history tells us that price-earnings ratios under those conditions go through the roof. What is really needed to keep stock market bubbles from occurring is a lot of product price inflation, which historically has tended to undercut stock markets almost everywhere. There is a clear trade-off. If monetary policy succeeds in one, it fails in the other. Now, unless we have the capability of playing in between and managing to know exactly when to push a little here and to pull a little there, it is not obvious to me that there is a simple set of monetary policy solutions that deflate the bubble." (Federal Open Market Committee meeting transcript, 24th September, 1996, pp. 30-31).

Driffill et al. (2005) analyse the argument that central banks tend to alter their interest-rate instrument gradually so as to protect banks from the vulnerability caused by sharp increases in short-term interest rates, and thus promote their macroeconomic objectives further than inflation targeting, such as that of financial stability. They prove theoretically that smoothing interest rates may lead to indeterminacy of an economy's rational expectations equilibrium. In particular, they extend the analysis of determinacy of equilibrium as in Bullard and Schaling (2002) and by investigating the inclusion of futures prices, and the associated basis risk, in the central bank's reaction function, they prove the existence of a trade-off between macroeconomic and financial stability. They, also, argue that this trade-off calls for caution, but does not necessarily imply that the central bank cannot smooth interest rates to reduce basis risk.

Bordo and Wheelock (2004) survey US stock-market booms and find that "booms do not occur in the absence of increases in real economic growth and perhaps productivity growth" (Bordo and Wheelock (2004), p. 41). Their analysis does not support the proposition that excessive money or credit growth leads to a boom in asset prices. However, they report that most asset-price booms that took place during the $19^{th}$ century occurred in times of monetary expansions. Notably, they strongly disregard the view that monetary policy can trigger speculation in the asset markets when it fails to control the credit supply. However, they present anecdotal evidence suggesting that at times the stock-market does rise above the levels justified by fundamentals. Bordo and Wheelock (2004) argue that "although one can offer plausible theoretical arguments for responding proactively to an asset price boom", as their survey suggests, "policymakers should be cautious about attempting to deflate asset prices without strong evidence that a collapse of asset prices would have severe macroeconomic costs" (Bordo and Wheelock (2004), p. 41).

Nevertheless, any attempt to evaluate the appropriate monetary policy response to asset price bubbles should not fail to consider primarily the explicit objectives of monetary policy (stabilising inflation and economic activity), and its ultimate aim to promote public welfare by fostering economic prosperity. Since asset price movements lead to macroeconomic fluctuations affecting prices and employment, the monetary authorities are bound to be concerned. It is also considered that if monetary policy manages to give a fitting and prompt response to the asset-price misalignments under consideration, the adverse macroeconomic consequences of the latter will be neither severe, nor long-lasting. In this line of argument, Mishkin (2008) advocates that "whether an asset price bubble is occurring or not, as asset prices rise and boost the outlook for economic activity and inflation, monetary policy should respond by moving to a more restrictive stance, [while] after a bubble bursts and the outlook for economic activity deteriorates, policy should become more accommodative" (Mishkin (2008), p. 2). He, nevertheless, makes the distinction that "… in most cases, monetary policy should not respond to asset prices per se, but rather to changes in the outlook for inflation and aggregate demand resulting from asset price movements, [which] implies that actions, such as attempting to 'prick' an asset price bubble, should be avoided" (Mishkin (2008), p. 2)[152] .

Nevertheless, Issing (2003) points out that the choice of the monetary policy strategy imposes a considerable influence on the stability of the financial system. He argues that if the primary objective of the central bank is to maintain price stability over the medium-term, then to pursue an inflation-targeting strategy with respect to a forecast of inflation spanning over one or two years may not be the optimal policy strategy at all times. He views that in a limited-horizon inflation forecast overall costs (that in terms of the central bank most commonly used tend to be future deflation that succeeds a financial crisis) may not receive the appropriate weight (see also Borio (2005) for further discussion on this point). Optimal monetary policy should, at times, under considerable strains in the financial system, accept deviations from the desired inflation rate over shorter periods so as to preserve price stability over the

[152] Mishkin (2007c) and Kohn (2006) also presents similar views on the response of monetary policy to asset prices.

medium to long run. Following this argument, one can also reach the conclusion that monetary policy decisions actually bear on the state of the financial system and may even enable the system to avoid a crisis and gain overall recovery. Equally, taking into consideration risk asymmetries, one can reach the same conclusions. Since a systemic financial crisis tends to produce rather substantial effects, optimal monetary policy may at times deviate by being considerably cautious, so as to reduce the likelihood of a crisis. Eventually, actual inflation will exceed expected inflation (optimally) for a period of time, due to the asymmetries involved, namely the very low probability of a very large loss (Issing (2003), p. 17).

Following the above line of argument, Issing (2003) also expresses the robustness of the ECB stability-oriented two-pillar monetary policy strategy over inflation (forecast) targeting. He stresses that "explicitly focusing on monetary and credit developments in order to form a judgment on consumer price inflation in the medium to long run forces the ECB to take a sufficiently forward-looking perspective…. This longer perspective highlights risks to price stability stemming from financial imbalances,… [and, thus,] the optimal price stability-oriented policy reaction based on monetary and credit developments is likely to diminish financial imbalances" (Issing (2003), p. 17)[153]. Trichet (2003) also recognises that the first pillar of the monetary policy strategy of the ECB enables an evaluation of the amount of liquidity within the euro area (by monitoring the deviations of the broad monetary aggregate (M3) deviates from its reference value), as well as its allocation. Since, in this way, credit and loan developments in addition to portfolio shifts are carefully monitored

[153] See also Issing (2002a) and (2002b) for a discussion on how the first pillar of the ECB monetary policy strategy can take into account financial imbalances.

and scrutinised according to the relevant financial and economic developments, potential risks of a bubble formation are thought to be signalled (Trichet (2003), p. 18).

The pre-emptive role of the first pillar of the ECB monetary policy strategy is also identified by Borio, English and Filardo (2003), who argue that: "…policy frameworks in which monetary aggregates still play a prominent role can more naturally accommodate policies aimed at addressing the build-up of financial imbalances… No doubt, such frameworks can make it easier to justify interest rate increases even in the absence of near-term inflationary pressures as long as the corresponding monetary aggregates are growing fast. … Pillar I in the ECB strategy is rationalised precisely in terms of providing better signals about inflationary pressures beyond short horizons, complementing the assessment of more near-term inflation pressures based largely on real-side indicators under Pillar II" (Borio, English and Filardo (2003), p. 43)[154].

Therefore, the debatable issue still remains of whether monetary policy should react directly to asset prices or, even, if asset prices need to appear in some form in a reaction function a central bank uses as a guide for monetary policy. Trichet (2003) suggests that "we should remain cautious about it, perhaps because it would be like opening Pandora's Box if we started setting our key policy rates according to asset price changes" (Trichet (2003), p. 16). He argues that extreme caution needs to be

[154] Nevertheless, Borio, English and Filardo (2003) also accept that even though "responding to rapid monetary growth … foreshadows *inflationary* pressures … financial imbalances can also herald recessionary, and so potentially deflationary, pressures down the road. This could raise delicate issues of communication and transparency unless a broader set of potential outcomes was explicitly considered" [emphasis is in the original] (Borio, English and Filardo (2003), p. 43).

exercised by monetary policymakers on this issue since it is considerably difficult both to assess asset price valuations and mostly to determine and measure fundamental asset-price values, which he views as highly hypothetical (Trichet (2003), p. 16). Therefore, he remarks that any evaluation whether asset-price changes reflect deep fundamental change or not is a challenging task and gives the NASDAQ tech-stock bubble as an illustration[155]. Mishkin (2008) also shares the same view concerning the difficulty in accurately identifying asset price bubbles and argues that if a monetary tightening is exercised in order to restrain an asset price bubble that is falsely identified, the prospects of economic growth may substantially deteriorate. Furthermore, Bernanke (2002) points out that when the monetary authorities are not confident in their estimations about both the presence of a bubble and its amplitude, the monetary policy actions aiming to affect asset price developments may lead to a misallocation of resources.

Nevertheless, Trichet (2003) stresses that a crucial issue is whether the central bank's stance should be different in a reversal of expectations due, for example, to a reassessment of expected profitability asset prices decline, in the effort to foster monetary and financial stability (Trichet (2003), p. 17).

It has been suggested that the monetary policy response to an asset-price bubble should be asymmetric in that when asset prices rise, central banks need not react provided there is no deviation from the price stability objective, while in the opposite

[155] Trichet (2003), in particular, points out that even though during 1996 market participants were thought to act in "irrational exuberance", capital spending increases due to the development of new technologies led to faster productivity growth that resulted in increases in equity prices. Relatively accurate asset valuations were difficult to undertake at the time due to uncertainties about fundamentals, even though central banks were actively concerned with the large movements in asset prices.

case during the unwinding a possible reaction is justified if it is estimated that monetary and financial stability are endangered. However, this asymmetric reaction, especially if it is held is a systematic manner, bears the cost of giving rise to moral hazard (as explained in Chapter 5)[156]. Therefore, it is questioned if a symmetric (systematic) monetary policy reaction to asset price changes is the appropriate solution. Trichet (2003) does not share that view based on the opinion expressed above that central banks cannot accurately assess asset-price deviations from their fundamental value. He considers that if the monetary authorities do not diagnose the presence of a bubble, thus, not devising an appropriate reaction, they actually encourage market participants to undertake riskier projects based on their false perception of a sound financial and economic environment, bringing about a problem similar to "disaster myopia" (as in Guttentag and Herring (1986)), (Trichet (2003), p. 17).

Nevertheless, De la Dehesa (2002) expresses the opposite view. He argues that the above view that central banks may create moral hazard by cultivating expectations that remedial monetary policy action will be taken if a bubble bursts, probably stems from the fact that market-price changes are, actually, asymmetric. He suggests that "this perception may not happen or may be reduced if the central bank reacts to asset price movements in a symmetric and transparent way" and "the instrument that seems to be more adequate to respond to asset prices developments is the conventional interest-rate policy, [since] experience has proven that traditional

[156] Research that analyses the incentive and moral-hazard effects that may arise by a central bank's considerably aggressive response to a collapse in asset prices includes, for example, Miller et al. (2000), and Caballero and Krishnamurthy (2003).

monetary policy is easier to implement and more effective than other alternative instruments such as the increase in margin requirements or policy signals to influence those movements" (De la Dehesa (2002), p. 2).

Furthermore, when policymakers face large fluctuations in asset prices but muted inflation expectations, it is considered whether inflation is measured accurately, as well as whether price stability is ensured. It is debated whether asset prices should be taken into account when defining price stability, and, generally, whether asset prices may play a significant role in the conduct of monetary policy. The underlying concept is that since valuations of assets are computed in a forward-looking manner, eventually asset prices incorporate expectations referring to future inflation and economic growth. Nevertheless, Trichet (2003) remarks that this view is undermined by the fact that it has been difficult to establish wealth effects in a definitive manner, which although it seems not to apply to the U.S., it is probably the case in the euro area. Additionally, he expresses concerns about the observed divergence of asset prices from the CPI and points out the potential of an "internal conflict, if the objective of price stability is defined by aggregating the changes in the CPI and the changes in asset prices … since the nature of both types of prices is fairly different" (Trichet (2003), p. 18).

Referring to the ECB monetary policy strategy, Trichet (2003) remarks that if monetary policymakers decide not to respond directly to asset price developments, after evaluating all the elements described by the indications of the first pillar (mentioned above), they certainly need to consider the consequences of these developments on aggregate supply and demand, as well as on the confidence and expectations of economic agents, as they may eventually exercise an effect on price developments (Trichet (2003), p. 18).

Furthermore, Mishkin (2008) argues that actions aiming to "prick" an asset price bubble should better be avoided for (at least) three reasons. Initially, because he accepts that it is difficult to identify asset price bubbles accurately and promptly, and secondly, because he contends that even if this is not the case, still the effect that interest-rate policy can impose on asset price bubbles is highly uncertain. He stresses that tightening interest-rate policy may prove considerably ineffective in its effort to restrain the bubble, since "market participants expect such high rates of return from buying bubble-driven assets"[157](Mishkin (2008), p. 2). Since he views bubbles as "departures from normal behaviour" he accepts that "it is unrealistic to expect that the usual tools of monetary policy will be effective in abnormal conditions" (Mishkin (2008), p. 2). Finally, he points out that since asset prices span over a large spectrum of assets trading in the relevant markets, and since in a single period a bubble may be present only in a segment of those assets, monetary policy actions may prove to be "a very blunt instrument in such a case, as such actions would be likely to affect asset prices in general, rather than solely those in a bubble"[158] (Mishkin (2008), p. 3).

Finally, Bernanke, Gertler, and Gilchrist (1999), Bernanke and Gertler (2001) and Gruen, Plumb, and Stone (2005) support the above view that monetary policy should not attempt to defuse asset price bubbles and only respond to changes in the

[157] Greenspan (2002) also further discusses this point.

[158] An additional reason proposed has been that many crashes of asset prices which have become associated with asset price bubbles have had very limited effects on the economy (see the propositions of Mishkin and White (2003) in Chapter 5).

prospects for inflation and aggregate demand as it is thought to lead to superior results even in the event of a bubble.

### 6.3 Alternative Policy Responses

Since certain types of asset price bubbles threaten the stability of the financial system, thus, creating adverse effects for the economy overall, it seems reasonable to evaluate whether government policies may be effective in addressing such asset price bubbles. An extensive discussion on this point, however, lies beyond the purpose of this thesis and, therefore, we only present a summary of some important issues raised.

Mishkin (2008), for example, highlights the merits regulatory policy can bring. He contends that since interest-rate policy faces the difficult task of managing price stability and maximum sustainable employment, regulatory policies and supervisory practices should focus on strengthening the financial system, rendering it less vulnerable to booms and busts in asset prices. Nevertheless, certain feature of these policies constitute main aspects of a properly-functioning prudential regulatory and supervisory system, such as prompt corrective action, close supervision of financial institutions to enforce compliance with regulations, careful monitoring of an institution's risk-management procedures, adequate disclosure and capital requirements, and sufficient resources and accountability for supervisors.

Mishkin (2008) suggests that additional elements of such policies should include regulations that are designed, first, with the aim to fix market failures, and, second, in a way that does not exacerbate the interaction between credit provision and asset price bubbles. Kashyap and Stein (2004), for example show that an increase in asset values during a boom leads to higher capital buffers at financial institutions, encouraging further lending when capital adequacy requirements remain unaltered. When the bubble unwinds, there may be a sharp drop in value of this capital, even rendering a cut in lending necessary. Goodhart (2008) also supports this point. However, the role of bank-capital requirements in fostering financial stability, including whether capital requirements should be adjusted over the business cycle or whether other changes in the regulatory structure are necessary to ensure macroeconomic efficiency is still a matter of a growing research[159].

Mishkin (2008) also stresses that proper regulatory policies need to address the soundness of individual institutions, but notes that, at times, "risks across institutions become highly correlated, and we need to consider whether regulatory policies might need to take account of these higher-stress environments in assessing the resilience of both individual institutions and the financial system as a whole in the face of potential external shocks" (Mishkin (2003), p. 3). Notably, concerning the correlation of such risks in a global setting, propositions have also been put forward such as the construction of global central banking institutions (see for example Calvo (2008)).

It is also recommended in Mishkin (2008) that the regulatory system should include a standard part comprising policies addressing the risks bubbles create to financial instability. Being standard, these policies should be operational irrespective of the

[159] Research to date has not reached solid conclusions. In addition to Kashyap and Stein (2004), Goodhart, Hofmann, and Segoviano (2005), and Gordy and Howells (2006) provide a discussion of the related issues.

estimated presence of a bubble. Nevertheless, he does not fail to admit that "because specific or new types of market failures might be driving a particular asset price bubble, some future bubbles will almost certainly create unanticipated difficulties, and, as a result, adjustments to the specific policy stance to limit the market failure contributing to a bubble according could be very beneficial if identified and implemented at the appropriate time" (Mishkin (2003), p. 3).

The above suggestion, though, fails on the problem created by the difficulty in identifying asset-price bubbles on the first place. However, Mishkin (2008) argues that for the case of stock-market bubbles, even though they are difficult to identify since they tend not to be driven by credit booms (which he views to render them less detrimental as their collapse is less likely to create financial instability), in the event of rapid asset-price increases co-existing with a credit boom, it may be more likely that asset prices do, in fact, deviate from their fundamental values, as looser credit standards may trigger the rise in asset prices[160]. Then, a bubble is more likely to be identified by financial regulators, in the face, for example of information about lenders weakening their underwriting standards and credit extensions rising at unusually high rates. This argument reinforces the suggestion that "a rapid rise in asset prices accompanied by a credit boom provides a signal that should lead central bankers and other financial supervisors to carefully scrutinize financial developments to see if market failures might be driving the asset price boom" (MIshkin (2008), p. 4).

[160] In particular, stock-market bubbles can do more harm if stocks are held by financial institutions and these institutions are allowed to include the market value of stocks in their capital base. According to Mishkin (2008), this practice was a feature of the Japanese bank regulatory system and he identifies it as one reason why the collapse of the stock-market bubble in Japan helped lead to fragility of the banking system and, as a result, was much more damaging to the economy (Mishkin (2008), p. 4).

## 6.4 Empirical Dimensions of Asset Price Bubbles

Theoretical models and their empirical applications suggest that even though it is widely accepted that asset prices offer (even partially) useful information to monetary policymakers in the short-term, views are mixed about whether they bear any strong link to the primary indicators of monetary policy (output gaps and inflation forecasts). Policymakers need to utilise a vast amount of, at times, conflicting information and imprecise indicators. In addition, they need to take real-time decisions regarding prospective economic growth and prices, without the benefit of hindsight.

Borio and Lowe (2003) examine the annual asset-price movements in 34 countries beginning in 1962, looking at 38 crisis episodes, only using data that available ex ante. They form an index of imbalances based on a credit gap (defined as credit growth deviations from trend), an equity price gap, and an output gap aiming in identifying incipient declines in asset prices, which may create significant real output losses. They argue in favour of the use of such an index as a guide for proactive monetary policy action. A similar index is used for the US during the 1920s by Eichengreen and Mitchener (2003), who show that it provides explanations of the severity of the Great Depression.

The analysis of Borio and Lowe (2003) justifies the presence of two completed asset price cycles since the 1970s. They, thus, extract two main results, namely, first, that asset-price and credit cycles often progress concurrently, and, second, that cycles seem to increase in magnitude. They contend that low inflation generates optimism about the economic environment which may further inflate asset prices in response to an increase in productivity growth than will normally be the case. Equally, an increase in demand increases the likelihood of a rise in asset prices, in the case of a central bank being credibly committed to price stability. They argue that a credible commitment to price stability, in the short-run, renders product prices less sensitive to an increase in demand, the opposite holding for output and profits, while the absence of inflation may influence monetary policymakers to delay restricting monetary policy as demand pressures build. They reach the conclusion that asset prices provide useful information and that individual as well as aggregate asset prices should be used as a tool for conducting monetary policy.

According to Filardo (2003), however, the suggestions in Borio and Lowe (2003) that a "leaning-against-the-wind" approach to policymaking may be the best policy, need further empirical research into robustness of their policy recommendations under alternative economic environments[161]. Filardo (2003), stresses that McGrattan and Prescott (2003) give an interpretation of 1929 which should be a cautionary tale for any monetary policy approach that stresses a "lean-against-the-wind" policy during a run-up in asset prices. In particular, McGrattan and Prescott (2003) propose a measure of capital stock and compare it to market capitalization in order to identify if an asset-price bubble is present. Using this measure, they conclude that during 1929 the U.S. stock-market was, in fact, undervalued and that an asset-price bubble was not present. They argue that the subsequent stock-market crash was a result of the severely tightening monetary policy, but not the unwinding of a bubble.

[161] However, according to Filardo (2003) Borio and Lowe (2003) "paint a picture of a very risky policy environment where financial instability is omnipresent and a natural consequence of economic success" and he recognises that this view reflects a long tradition in macroeconomics, as e.g. in Minsky (1982), (Filardo (2003), p. 295).

In addition, Filardo (2003) suggests that further investigation into bank regulation may uncover some unintended adverse consequences of some of the policy recommendations given by Borio and Lowe (2003). For example, the authors offer a recommendation that regulators use tighter capital standards during an expansion in order to restrain unwarranted optimism. However, in such a situation, Filardo (2003) argues that financial funds would flow out of the regulated banking sector into the relatively unregulated nonblank financial markets. Not only would this artificially reduce the beneficial role that banks play in the provision of loanable funds, but it would also boost the size of the unregulated nonblank financial sector, which would presumably fuel further unwarranted optimism and asset price appreciation. Hence, according to Filardo (2003) in this case, a "leaning against the wind" policy may have the opposite effect on financial stability than policymakers would expect (Filardo (2003), p. 295-296).

Detken and Smets (2004) study financial, real and monetary policy developments during asset price booms examining 38 boom periods in 18 OECD countries since the 1970s. Their results reinforce the findings of Borio and Lowe (2003) referring to the build-up of large real, financial and monetary imbalances, which may constitute a good indicator of potential financial and macroeconomic instability[162]. However,

[162] They find that "real GDP growth is particularly strong during the boom, which is mainly driven by total private investment and is also reflected in housing investment, in both cases both in terms of growth rates as well as gaps (i.e. deviations of the investment ratios to GDP from estimated stochastic trends), and … monetary policy is looser during boom periods than in normal times as is revealed by deviations from the Taylor rule, as well as money and credit conditions" (Detken and Smets (2004), p. 31). In addition considering all booms, they find that in the boom phase inflation rates do not move substantially, despite rises in deviations from trend. They also find that those booms that preceded large recessions or even financial instability, tend to last longer and experience substantially greater real and monetary imbalances; they also tend to be characterised by a large boom and bust in the real-estate market. Finally, they find that cases of 'high-cost booms' also present a relatively more positive inflation gap, namely greater deviation of inflation from its trend, after the boom, despite the large fall in investment and output.

they do not provide an answer to whether 'pre-emptive' monetary policy tightening may be successful in preventing or alleviating subsequent asset price collapses without imposing a considerably high cost.

Furthermore, Bryan, Cecchetti, and O'Sullivan (2003) argue that asset prices offer useful information for monetary policymakers and that the latter should avoid using measures of inflation that focus only on the current cost of current consumption. They mainly underline the importance of inter-temporal analysis, argue against policymakers' relying to a great extent on current consumer price index prices, and point out the challenging task of capturing the changing prices of non-financial assets. Bryan, Cecchetti, and O'Sullivan (2003) point out that in periods of real interest rate fluctuations, price information may be biased.

The key policy implication of Bryan, Cecchetti and O'Sullivan (2003) is that their new measure of inflation is higher than CPI inflation in the late 1990s, reflecting the rapid increase in asset price inflation. If the increase in asset prices was due to higher expected goods prices, then their method would lead the monetary authority tighten monetary policy and reduce the inflationary pressures. If, however, the increase in asset prices was due to an asset price bubble, then the Bryan, Cecchetti, and O'Sullivan (2003) method would generate an upward bias in their cost of life inflation measure and cause the monetary authority to pursue an unnecessarily tighter monetary policy, which could have scuttled the expansion and deepened the 2001 recession[163] (Filardo (2003), p. 292).

[163] Filardo (2003) makes the association with Alchian and Klein (1973), and identifies that the problem then, similar to the one at the time of publication, was how best to incorporate observed future prices into a standard price index. Alchian and Klein (1973) solve this problem by constructing a hypothetical asset price that would be observationally equivalent to having the full set of future

McGrattan and Prescott (2003) have developed a way to determine whether the stock market is overvalued or undervalued and applied it to the 1929 U.S. stock market. They found that the reason for the 1929 crash was not that the stock market was overvalued relative to fundamentals. Significant overvaluation of the stock market is a reason for concern, because if the market is overvalued, the likelihood of a crash is high, and a crash would result in large declines in net worth of people and corporations[164]. McGrattan and Prescott (2003) also raise the question if there are any consequences to the stock market being undervalued and give an affirmative answer. In particular, an undervaluation will lead to greater underinvestment in the corporate sector and lower economic efficiency.

In the question whether the U.S. Federal Reserve should consider the consequences of its policy for the value of the stock market, their answer is negative. They stress that "the role of the Federal Reserve is to maintain an efficient payment and credit system, and it should not consider the effects of its policies on the value of the stock market, while the central bank should not try to prop up the value of the stock market as it did in Hong Kong and Taiwan or depress the stock market as the Federal Reserve did in the United States in 1929" (McGrattan and Prescott (2003), p. 274).

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prices. Bryan, Cecchetti and O'Sullivan (2003) propose an interesting method to try to approximate the Alchian and Klein (1973) hypothetical asset price by using a dynamic factor model. According to Filardo (2003) the authors have made a useful extension of the empirical methods to examine Alchian and Klein's cost of life inflation measure but do not show how to resolve the bias induced by asset price bubbles. Additionally, he proposes that they construct a more unbiased estimator of the Alchian and Klein inflation estimate by trying to extract future price information with modern finance methods or by empirically controlling for asset price bubbles – which he admittedly views as neither particularly straightforward nor easy (Filardo (2003), p. 292-293).

[164] A stock market would cause state and local pension plans to suffer large declines in the value of their assets, and this would necessitate increases in taxes if promises were to be honoured. The same decline would occur for private defined benefit plans, which would further reduce the value of the stock market. People with individual retirement accounts would also suffer losses. In such situations, there is a danger that policies will be adopted that have adverse real economic effects (McGrattan and Prescott (2003), p. 274).

Arguing on who should deal with stock market overvaluation or undervaluation other than the central bank, they accept that economists should convey to the public information about the degree of overvaluation or undervaluation. If the public has this information and acts on it, the problem of incorrect stock market valuation will not arise[165].

According to Filardo (2003), if McGrattan and Prescott's study is correct in its result that there was no asset price bubble at the height of the market, then the 1929 crash and its aftermath is a good example of the costs of fighting an asset price bubble when a bubble is not really present, and such estimates can be used to calibrate models in which this type of cost is a parameter. Overall, Filardo (2003) suggests that policymakers should be sceptical about reacting to asset price movements that look like bubbles (Filardo (2003), p. 294).

## 6.5 Implications of Asset Price Bubbles for Monetary Policy

Even though asset prices are considered to convey useful information for monetary policy makers in the short term, it is still debated whether asset prices have any significant relationship to the primary indicators for monetary policymakers.

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[165] McGrattan and Prescott's (2003) theory is that the crash was due in large part to the Federal Reserve's reaction to the rising stock prices, which it viewed as reducing real investments in the corporate sector. Determined to stem investment in stocks, the Federal Reserve increased short-term interest rates dramatically (see McGrattan and Prescott (2001b) figures 5 and 6). By the middle of 1930, stocks had recovered much of the ground lost in 1929. Perhaps the crash could have been avoided. This historical episode is strong evidence that Federal Reserve policy can create a stock market crash by disrupting the credit system. If stock market participants are subject to an unexpected credit crunch, a stock market crash is likely (McGrattan and Prescott (2003) p. 273-274).

Cecchetti, Genberg, Lipsky and Wadhwani (2000) examine the potential usefulness of a monetary policy reaction to changes in asset prices generalising the seminal analysis in Poole (1970), which indicates that "leaning against the wind" of interest-rate changes is useful when disturbances originate in the money market. They allow for equity (or real estate) price movements in an economy where the stock market (or the housing sector) is crucial and for exchange rate changes in an economy where the external sector is particularly important. They show that monetary policy attempts to moderate asset-price changes tend to diminish economic activity fluctuations provided that the movement in an asset price is generated from a disturbance in the demand and/or the supply of the asset under consideration. If the change in asset prices is generated by disturbances in other markets (than the money market as in Poole's analysis) the same rationale applies. In the case, for example, of a rise in equity prices due to positive productivity shocks, they suggest that "leaning against the wind" of the asset price changes is recommended. They contend that monetary policy should automatically react to asset-price changes, but point out the importance of separate evaluation of each situation before the relevant actions are undertaken.

Cecchetti, Genberg, Lipsky and Wadhwani (2000) also use the insights of Kent and Lowe (1997) that build a dynamic model, which explicitly qualifies for misalignments in asset prices, in order to demonstrate that asset price misalignments should be taken into account in the normal course of determining monetary policy, due to the impact they impose on expected inflation, and due to their potential of creating unnecessarily large business cycle fluctuations. Their conclusions are further confirmed by the results in the simulations presented by Ceccheti, Genberg and Wadhwani (2003)[166].

Although monetary policy actions may, under certain circumstances, be effective in affecting asset prices, Cecchetti, Genberg and Wadhwani (2003) stress that such policy actions are considerably difficult to apply. They maintain that a build-up of asset price misalignments tends to result in misaligned exchange rates, macroeconomic imbalances, and lost competitiveness. In the face of shocks hitting the asset markets, monetary policy actions in an effort to “lean against the wind” of asset price changes are suggested as being more likely to balance outputs. After a modest monetary policy reaction to asset price misalignments macroeconomic performance has been improved, for the cases of financial shocks being the underlying determinants of theses misalignments. Yet when the latter are due to shocks to productivity or changes in fundamentals, the monetary policy reactions seem not to be useful. Cecchetti, Genberg and Wadhwani (2003), thus, reach the conclusion that a mechanical monetary policy response to all asset price changes can eventually give rise to outcomes that are worse than those created when there is no response all. They further draw attention to certain factors that may weaken the effectiveness of monetary policy responses, like the role of the banking sector, the resilience of the financial system, and the openness of the economy.

[166] They run simulation experiments of monetary policy responses to asset prices in three macroeconomic models. The first model studies the appropriate response to bubbles in the stock-market and is a small closed economy model as in Bernanke and Gertler (1999). Their next model is as in Batini and Nelson (2000), namely a small open-economy model that highlights the role of changes in the exchange-rate. Their third model is similar to Taylor’s multi-country model built originally in order to examine international economic interdependence.

Furthermore, Goodfriend (2003) also accepts that changes in asset prices convey useful information to monetary policymakers. However, he maintains that “the important point is that the unconditional correlation between asset price movements and real short-term interest rates generated by monetary policy geared to maintaining price stability could be either negative or positive” (Goodfriend (2003), p. 447)[167]. He argues that it may prove counterproductive to target asset prices, as well as that the downside risks of inappropriate monetary policy action exceed the benefits potentially created by useful intervention. He recognises a number of practical problems that monetary policymakers face while addressing asset-price bubbles. Initially, he argues that the information extracted is not perfect as markets cannot capture all available information, monetary policymakers draw information from measurements that are not perfect, and different asset prices may produce contradictory signals. He contends that “monetary policymakers cannot hope to identify and address all inflation and output misalignments” (Goodfriend (2003), p. 450). Goodfriend (2003) also points out that reputation and credibility which are crucial to central banks can be both put at risk by inappropriate, or poorly executed policy actions. Since the accurate identification of shocks as misalignments is a difficult task, the risk of implementing the inappropriate policy and losing credibility is considerably large. If credibility weakens, however, central banks become less capable in their efforts to foster financial stability. Finally, he is not convinced whether asset price information is useful to exchange-rate or interest-rate policy.

[167] He, further, notes that “the direction and size of the unconditional correlation would depend on the size, frequency, and duration of aggregate demand and supply shocks, the central bank’s power to identify the shocks promptly, and the size and duration of the interest rate responses needed to maintain price stability” (Goodfriend (2003), p. 447).

In addition to Goodfriend (2003), Friedman (2003) is also sceptical about the usefulness of “mechanical extrapolations” from asset prices, because he also accepts the significant risks of mis-measurement and misinterpretation. With reference to the experience in Japan during the late 1980s he stresses that asset prices did not provide useful information in real time.

Friedman (2003) finds it useful to begin by asking what lies behind the great interest today in the potential implications of asset prices for monetary policy and suggests three separate motivations. First, despite the noteworthy success of monetary policy, both in the United States and elsewhere during the ‘Great Moderation’ era, there is always the challenge of seeking improvement. Second, he expresses the “acute” desire to draw all possible lessons from the Japanese debacle of the 1990s, since it is believed that the Japanese could have not been as negative if the Bank of Japan had taken account of the sharp rise and fall in the country’s equity and real estate markets in a different way than it did. Finally, he accepts that there is also at issue “a form of disguised reaction” against the increasingly narrow interpretation of what monetary policy is all about, especially in central banks outside the United States, including in particular the increasingly widespread adoption of “inflation targeting”[168] (Friedman (2003), p. 459).

Given the universal agreement that monetary policy should respond to asset prices if they do contain such information, the operative question for debate is what to do if asset prices do not contain such information. The view expressed in Goodfriend

[168] A proposition, with which nobody today disagrees, as Friedman (2003) suspects, is that the central bank should take account of asset prices to the extent that asset prices bear incremental information about the macroeconomic goals of monetary policy, whatever they may be.

(2003) is that if asset prices do not contain incremental information about the macroeconomic goals of monetary policy, the central bank should ignore them.

However, because the central bank cares about the consequences of asset prices for the financial markets, it is generally argued that it should take asset price movements into account even if they do not directly contain incremental information about the macroeconomic goals of monetary policy. Greenspan (1999), for example, has argued, " … that there is a form of asymmetry in response to asset rises and asset declines … Central banks do not respond to gradually declining asset prices … to gradually rising asset prices … to sharply reduced asset prices, which will create a seizing up of liquidity in the system" (Greenspan (1999), p. 143). Making reference to the damaging potential implications for the financial markets liquidity, Greenspan (1999) gives a logical explanation for why the central bank would plausibly react to asset prices even if they did not bear information that is directly useful for predicting future outcomes of the macroeconomic goals of monetary policy.

Cecchetti, Genberg, and Wadhwani (2003) give an entirely different reasoning from Greenspan (1999) to the same answer that the central bank should react to asset prices even if they do not contain incremental information about the macroeconomic goals of monetary policy. Their main argument is that central banks should respond to asset prices since they contain information about macroeconomic goals that a central bank has, and indeed ought to have, but either cannot or will not publicly admit to have.

According to Friedman (2003), Cecchetti, Genberg, and Wadhwani (2003) focus on "medium-run macroeconomic stability", in other words, on the second moment of real economic outcomes. Medium-run macroeconomic stability, as defined in the latter, is accepted by Filardo (2003) as a plausible enough goal for monetary policy to pursue, presumably alongside the goal of low and stable price inflation. If asset prices provide useful information to the best available forecast of prospects for such medium-run macroeconomic stability, Filardo (2003) wonders why this is not simply a specific case of the general proposition on which everybody already agrees. He contends that the answer lies in the fact that Cecchetti et al. (2003) take as given (and, in fact, applaud) the monetary policymaking framework of "inflation targeting" (Friedman (2003), p. 460).

Bernanke and Gertler (2001) stress that a considerable debate on the appropriate role of asset prices in the design of monetary policy has sprung with contributions including, among others, Filardo (2000), Goodhart (2000), Batini and Nelson (2000), while Cecchetti, Genberg, Lipsky and Wadhwani (2000) seems to be the analysis most closely related to Bernanke and Gertler (2001). In fact, Cecchetti et al. (2000) employs simulations of the model used in Bernanke and Gertler (2001)[169]. In contrast to the latter, however, the results in Cecchetti et al. (2000) strongly support the inclusion of stock prices in the central bank's policy rule[170]. They identify optimal policy only in the case of the central bank knowing with certainty when the bubble will burst and that the stock-market boom is, in fact, driven by non-

[169] In particular, they use the model in Bernanke and Gertler (1999) which is the same as in Bernanke and Gertler (2001).

[170] According to Bernanke and Gertler (2001) the difference in conclusions between their work and that of Cecchetti et al. (2000) stem's from computing the policy rules by not accounting either for the probabilistic nature of the bubble or the possibility that shocks other than a bubble may be driving asset prices. In particular, Bernanke and Gertler (2001) disapprove the fact that the latter "optimize the policy rule with respect to a single scenario, a bubble shock lasting precisely five periods, rather than with respect to the entire probability distribution of shocks, including shocks other than bubble shocks" (Bernanke and Gertler (2001), p. 256).

fundamentals, which are both highly unlikely. Conversely, Bernanke and Gertler (2001) show that even "if the central bank is certain that a bubble is driving the market, once policy performance is averaged over all possible realizations of the bubble process, by any reasonable metric there is no consequential advantage of responding to stock prices, and a too-aggressive response to stock prices can create significant harm in that scenario" (Bernanke and Gertler (2001), p. 256). They also remark that a deficiency in their approach is that the non-fundamental component of stock prices is treated as exogenous. A similar result is found by Batini and Nelson (2000) referring to real exchange-rate bubbles. Bernanke and Gertler (2001) posit that "the macroeconomic stability associated with inflation-targeting is likely to reduce the incidence of panic-driven financial distress that could destabilize the economy", yet recognise the need for further research on the issue (Bernanke and Gertler (2001), p. 256).

### 6.6 Booms and Busts in Asset Prices: Towards a Consensus

The experience of asset-price booms and busts has, historically, suggested that their impact on the real economy varies. The most costly episodes in social and economic terms tended to be those accompanied by high leverage and a large build-up in credit[171].

[171] Additionally, according to Plender (2003) asset-price bubbles (in particular equity-market bubbles) create a further significant cost as they encourage over-investment in suboptimal projects. McKibbin (2003) further gives simulations from a 'G-cubed' model that support the conclusion that excessive investment creates the major, and at times very persistent effects of asset-price misalignments on the real economy.

The discussion in Richards and Robinson (2003), for example, addressed the role of monetary policy during a boom in asset prices and their collapse. Economists generally advocate an aggressive monetary policy response to the contractionary effects generated by sharp declines in asset prices, especially if deflation risk becomes significantly high. Posen (2003), for example, clearly states the above even though he also highlights that fiscal policy should be utilised in addition to monetary policy, and policymakers need identify any form of fragility in the financial and corporate sectors. In view of this agreement with respect to the possible monetary policy response in the aftermath of asset-price booms, the debatable issue that remain is the role of monetary policy during the development of a boom in asset prices, in particular under qualified concerns that the latter may deviate from fundamentals.

Richards (2003) recognises that a few years prior to the year of publication opinions were rather polarised on the problem of devising an appropriate monetary policy response to the development of an asset-price boom. One view (expressed, for example, by Bernanke and Gertler (2001)) maintained that monetary policy should not consider the developments in asset markets, unless they influence inflation forecasts in the horizon where the central bank targets inflation. The opposite view (as, for example, in Cecchetti, Genberg and Wadhwani (2003)) held that monetary policy should respond pre-emptively by using tightening interest-rate monetary policy in an attempt to restrain asset-price misalignments in asset prices in their development. Richards (2003) stresses that “the debate has shifted towards the middle ground”, arguing that “monetary policy should not aggressively attempt to burst perceived asset-price bubbles, but should take account of asset-price fluctuations, to the extent that they provide information about the shocks affecting the economy, or have possible implications for output and inflation in the medium term, beyond the usual inflation-targeting horizon" (Richards (2003), p. 3). This implies that an inflation-targeting framework for the conduct of monetary policy needs to be exercised with greater flexibility[172].

Bean (2003) is evidence of the above 'shift to the middle ground', as he argues that monetary policy that uses a forward-looking 'flexible inflation-targeting framework in setting interest rates must consider the longer-run consequences that asset prices and financial imbalances create. He expresses the view that asset prices may enter an optimal monetary policy rule, deriving from an objective function that minimises the output gap and deviations of inflation from its target, instead of considering whether asset prices should be directly incorporated in a Taylor-type rule or an inflation-targeting rule. Bean's (2003) analysis suggests a broader role for monetary policy than advocated by the view expressed, for example, by Bernanke and Gertler (2001) since he argues that monetary policy should respond to asset prices provided that they signal changes in expected inflation or, additionally, activity. He also argues that this approach is consistent with the behaviour of several central banks, such as inflation-targeting central banks (like the Bank of England), which, may have the inflation rate as their 'first-level target, but face broader mandates which include paying attention to economic growth and employment.

Bean (2003) emphasises that even though a mechanical monetary policy response to any single asset price is not appropriate, monetary policymakers need to utilise information extracted from asset prices referring to the shocks affecting the economy

[172] Earlier evidence on this argument is found in Ball (1997) and the research in the conference on 'Monetary Policy and Inflation Targeting organised by the Reserve Bank of Australia during 1997.

and their implications for future inflation and growth. When the evaluation of such information gives a signal that the risk of potential financial instability is increasing by an overheating economy, monetary policymakers need to address the implications this may have for inflation and future activity. Therefore, an inflation-targeting regime needs to monitor asset prices and their implications for medium-term risks to the economy overall.

Gruen, Plumb and Stone (2005) suggest that a central bank's tightening of interest rates may cause a bubble to burst more severely, and, thus, increase the potential detrimental effects to the economy. They provide further evidence to support the view expressed by Bean (2003) that monetary policy cannot make a 'single automatic response' to asset-price developments. In particular, Gruen, Plumb and Stone (2005) study a model of an economy in which a bubble in asset prices results in increases in aggregate output and inflation, considering a bubble that in each future period either continues its development or bursts, with known probabilities. Since monetary policy can impose an effect to the economy only with a lag, the monetary policymaker faces two conflicting policy options, namely either to use restrictive policy in order to reduce inflation and output pressures (and possibly encourage the bursting of the bubble), or to implement accommodative monetary policy in order to prepare for the eventual unwinding of the bubble. In their model the optimal policy depends on the specific characteristics of the process that the bubble follows, as well as the nature of the costs created by its unwinding. Stockton (2003), however, commenting on an earlier version of the above, argues that since monetary policymakers are confronted with great uncertainty with respect to the existence of bubbles, even more about their stochastic characteristics, it is unlikely that the informational requirements for optimal policy in the model of Gruen, Plumb and Stone (2003) will be satisfied. They, yet, reach the conclusion that the appropriate monetary policy relies heavily on the policymakers' judgment, as under certain circumstances the central bank should better "lean against the bubble", while under others this policy response would be counterproductive. They, finally, point out that, given the information available, it may be difficult to distinguish in real time which of the above is the case.

On the contrary, Cecchetti (2003) argues more fervently in favour of monetary policy reacting to asset-price misalignments so as to counter potential instability, yet exercising caution. He refutes the opposite view by pointing out three main points. First, he argues that even though equilibrium asset values are difficult to estimate, asset price misalignments still need to be identified by monetary policymakers, similarly to potential GDP, for example that is routinely measured irrespective of the difficulty in estimation. He, further, does not accept that monetary policymakers should ignore the possibility of the development of bubbles in asset markets expect them to be eliminated by efficient financial markets. Second, he stresses that a monetary policy reaction is justified even under the possibility that excessively activist monetary policy may be destabilising to the economy. He argues, in fact, that this rather necessitates considerable caution in the extent of the monetary policy action. Third, he points towards the existence of central-bank communication problems in an effort to justify a response to a potential bubble, but contends that these no more severe than communication issues raised by normal interest-rate increases aiming at stabilising prices and growth in the medium term[173].

The results in Cecchetti (2003) show that the officials at the U.S. Federal Reserve had been more concerned in their discussions with asset prices when valuations were increasing during the 1990s, and discussing a possible adjustment of policy in order to "lean against the bubble". Contrasting the results to his analysis to Federal Reserve officials' public statements, Cecchetti (2003) concludes that not enough evidence has been given that monetary policy can be used to defuse bubbles and limit the destructive consequences when they burst. For example, Greenspan (2002) concluded that "it seems reasonable to generalize from our recent experience that no low-risk, low-cost, incremental monetary tightening exists that can reliably deflate a bubble. But is there some policy that can at least limit the size of the bubble and, hence, its destructive fallout? From the evidence to date, the answer appears to be no" (Greenspan (2002), p. 5).

Notably, Shiller (2003) points out the difference in approach to research on asset price bubbles by stressing that "microeconomists still rarely cite macroeconomists, economists rarely site psychologists, and academics rarely cite news media stories." Therefore, he further remarks that the research on asset-price bubbles, in general, yields fragmentary conclusions (Shiller (2003), p. 36). Hunter, Kaufman and

[173] Cecchetti (2003) also presents empirical evidence on the conduct of monetary policy in the U.S. by examining transcripts and minutes of the Federal Open Market Committee (FOMC) investigating references to keywords referring to asset-market valuations. He finds that the frequency of these references to be correlated with a measure of the equity-market overvaluation. His results show that as equity-market valuations were rapidly rising during the 1990s, the frequency of discussion in the FOMC about the equity market increased to a great extent. He, further, estimates a policy reaction function for the US and provides evidence that the interest-rate levels during the period from 1990-2003 showed positive correlation with a measure of overvaluation of the equity market and negative with a measure of banking-system stress.

Pomerleano (2003) present a synthesis of the different strands of research in an effort to provide a comprehensive account of “what asset price bubbles are, how they might be identified, and – most importantly – what should be done to avoid or limit the destructive havoc they may inflict on the financial system and economy” (Hunter, Kaufman and Pomerleano eds. (2003), p. 13).

Shiller (2003) remarkably points out that “there appears to be a fundamental disconnect in our thinking about asset price bubbles and, in fact, highly educated people seem to differ at fundamental levels” (Shiller (2003), p. 35). By a bubble, some seem to mean any period when asset prices rise and then fall – Mishkin and White (2003), for example, define a stock-market crash in this way. He, thus, contends that the challenging concept of a bubble requires more than the above definition presents. The traditional notion of a speculative bubble is according to Shiller (2003) “a period when investors are attracted to an investment irrationally because rising prices encourage them to expect, at some level of consciousness at least, more price increases” (Shiller (2003), p. 35). A feedback develops – as people become more and more attracted, there are more and more price increases. The bubble comes to an end when people no longer expect the price to increase, and so the demand falls and the market crashes (Shiller (2003), p. 35).

There may be several different ways to analyse asset markets. As presented in Chapter 5, among others, for example, McGrattan and Prescott (2003) emphasise rational reactions in the markets to tax-law changes, while Allen and Gale (2003) refers to rational reactions to agency problems. Cohrane (2003) stresses the convenience yield of speculative assets, and DeBondt (2003) takes a different stance emphasising an array of psychological factors. This diversity is a reflection of the complexity of these markets. Shiller (2003) believes, though, that “the diversity is also a reflection of the diversity of intellectual traditions that may be applied to understanding speculative markets” (Shiller (2003), p. 36).

Shiller (2000) presents a view of speculative markets that is in many ways an attempt to synthesise a lot of diverse information. In his model of speculative bubbles, he distinguishes between precipitating factors for the bubble and amplification mechanisms that enhance the effect of these factors. Moreover, he considers the cultural factors that mediate the bubble and the psychological factors that provide the human substrate on which the bubble can grow.

The amplification mechanisms that make a bubble grow strong are simply that increases lead to more price increases, through human psychology. Initial price increases attract investors’ interest and demand, and the new demand causes more price increases. A vicious circle can actually occur, whereby prices accelerate upward. The price increase cannot continue infinitely, and eventually the disruption of price increases damages the investors’ motivation to hold the highly priced stocks. At that point, the price increase may be sharply reversed, the bubble is burst, and there can be a downward feedback, leading to lower and lower prices. Shiller (2003) contends that this simple amplification mechanism is well known and has been discussed for centuries, but, he points out that curiously it is rarely mentioned by economic research. He notes that “from this lack of discussion, one might easily assume that such amplification is discredited by some scholarly work, while, in fact, no such scholarly work exists" (Shiller (2003), p. 38)[174].

Shiller (2003) recognizes that the list of precipitating factors is even longer than the list he gave in Shiller (2000). It is, in fact, the bewildering variety of changes that affect the stock markets that makes it so hard for us to understand asset price bubbles. He believes, however, that there are certain things that we understand about speculative markets that incline them towards a large response to large price changes, notably the amplification mechanisms. Beyond this, we learn from the diverse arguments about the direction of the stock market a little humility in trying to predict its future movement (Shiller (2003), p. 36-37).

A very different line of reasoning in given by Meltzer (2003) who argues that asset prices contain information about future inflation. In earlier work of his (as for example Brunner and Meltzer (1989)), he models asset prices to respond to monetary and fiscal policy actions, in addition to changes in the size of the capital stock and the expected return to real capital. He finds that "these general equilibrium models of money, bonds, and capital give no support to recent proposals urging policymakers to respond to asset price changes… these models can be consistent with the 'fat tails' found in most asset-price distributions" (Meltzer (2003), p. 31).

[174] Shiller (2000) gives what he admittedly thought of as a long list of precipitating factors for the stock market bubble that began in 1982, (others define those events as individual bubbles) accelerated in the late 1990s and peaked in early 2000. In particular, he gives 12 factors: The advent of the World Wide Web and its psychological impact, triumphalism in the West as Western free market solutions are adopted around the world, an emerging culture of business success, a Republican US Congress and capital gains tax cuts, the baby boom from 1946 to 1966 and its delayed effect on the demand for stocks, expanded news media coverage of business news, a trend towards increasingly optimistic stock-market analysts' reports, the rise of pension plans, the rise of mutual funds, the worldwide decline in inflation the lowering of transactions costs and the expanding volume of stock market trade, and the increasing public interest in gambling and the association of self-esteem with winning.

Meltzer (2003) argues that asset prices in these models, and as he contends in reality as well, reflect anticipations of inflation. He notes that "the response of asset prices with low transaction costs typically occurs before there is an increase in the prices of many goods and most services, yet asset prices also rise for reasons not related to inflation" (Meltzer (2003), p. 31). He, thus, cannot accept that monetary policymakers possess a greater ability to extract the response of asset prices to monetary expansion or identifying inflationary and non-inflationary components as they arise. He hopes that future research develops techniques that will enable a reliable separation of the determinants of asset prices and remarks that the information contained in asset prices can be utilised in constructing more accurate inflation forecasts when research provides such a reliable rule. Meltzer (2003) stresses that "we are not there, we are not even close to having a useful model of asset prices that separates the various sources of change"[175] (Meltzer (2003), p. 31).

Finally, Meltzer (2003) argues that general equilibrium models do not support a monetary policymakers' response to changes in asset prices. In addition, studies of the experiences during major bubble episodes do not provide a sound explanation of buyer and seller behaviour. He stresses that drops in asset prices, even large ones, are not necessarily followed by output price deflation or long-lasting and deep recessions. He notes that the U.S. stock market decline in 1987 and the NASDAQ decline in 2000 have not been followed by deflation or recessions, like the experience of the U.S. during the 1930s or Japan during the 1990s, and that such

[175] Meltzer (2003) highlights the need for research to provide solid alternative propositions to rational bubbles, or even irrational bubbles, as he believes that "those alternative hypotheses could do more to advance our discipline than continued work on empty propositions about rational bubbles or irrational behaviour" (Metzer (2003), p. 31).

episodes suggest that expansive economic policies may compensate for any deflationary effect that asset prices impose on output prices.

That asset prices can, should, and actually do play a significant role in the responsible conduct of monetary policy is a central point Mussa (2003), who makes two qualifications. First, prices of key assets including equities, bonds, real estate, and foreign exchange are important macroeconomic variables, and their behaviour generally has implications for what monetary policy is fundamentally concerned with – namely, the maintenance of reasonable price stability and, more generally, the stability and growth of the economy. In particular, he recognises that asset prices are among the leading indicators that help predict the likely future behaviour of the price level and the level of economic activity. Accordingly, he argues that the behaviour of asset prices should normally have some effect on monetary policy, along with that of other useful economic indicators. Nevertheless, he notes that other than their importance as macroeconomic indicators, asset prices need, in some cases, to exert a special influence on the monetary policy conduct (Mussa (2003), p. 41).

Second, he argues that the behaviour of asset prices should not be targeted[176] as one of the key objectives of monetary policy or that monetary policy should seek to stabilize asset prices. Asset prices, especially equity prices, are highly volatile. The reasons for all of the asset price volatility that we observe are not entirely understood – although an important part of it relates to market responses to the receipt of new information. He argues that it is neither feasible nor desirable for monetary policy to suppress most asset-price volatility. He does not find it relevant for monetary

[176] As in Blanchard (2000).

policymakers to "link adjustments in monetary policy is some mechanical way to movements in asset prices (i.e., to include asset prices as a determinant of monetary policy, as might be suggested by some extensions of the Taylor rule), [since] the issue is whether there are identifiable circumstances – not necessarily frequently occurring or always easy to describe precisely in advance – when monetary policy should adjust in the light of developments in asset prices" (Mussa (2003), p. 42). Mussa (2003) argues that there are such circumstances and that their occurrence is not so implausible as to be practically irrelevant, although their idiosyncratic nature is such that it is difficult to describe a rule to govern the appropriate monetary policy response[177] (Mussa (2003), p. 42).

Trichet (2003) stresses that it does not seem appropriate to include asset prices into a rule for monetary policy that the central bank should commit to or into a central bank reaction function. He also questions which asset price would be more relevant for monetary policymakers to take into account, only stock prices, or include housing prices, exchange rates, the cost of capital as well. Trichet (2003) as well does not support the introduction of asset prices into the measurement of inflation or the definition of price stability. The reasons he presents are, first, that "the nature of goods and services on the one hand, and assets on the other hand, are quite different and so is the information contained in their prices … that asset prices are highly

[177] After giving a brief account of the misconduct of monetary policy in Japan during the late 1980s to the early 1990s, Mussa (2003) concludes that the point of his criticism is that paying greater attention to the behaviour of asset prices (beyond the one normally accorded in the conduct of monetary policy) would have helped to avoid the serious errors made. He notes that if Japanese monetary policy had paid greater attention to the build up of the asset-price bubble in equities and real estate (and to its effects on the macroeconomy), there would have been good reason to start tightening more aggressively before clear signs of overheating finally showed up in consumer-price inflation. Symmetrically, if greater attention had been paid to the drop in equity values and the housing market, there would have been good reason to ease monetary policy more aggressively in anticipation of the usually lagged decline in consumer-price inflation (Mussa (2003) p. 49).

volatile, much more volatile than other prices, especially in the current context of low inflation, [thus] it might be difficult to implement a sound monetary policy by focusing on highly volatile indicators. Finally, it is highly questionable that one could determine scientifically what an asset price equilibrium value is" (Trichet (2003), p. 22).

Despite the useful role asset prices may have as a guide to monetary policy, Mussa (2003) raises the question of how this can be explained to the public. And even questions "why … central bankers generally appear so reluctant to admit that the behaviour of asset prices might influence their decisions about monetary policy when many (but not all) outside analysts of monetary policy suggest that there should be such an influence" (Mussa (2003), p. 49). He argues that part of the answer lies in the fact that while consumer-price inflation is generally unpopular, asset price inflation is much appreciated by those who own the assets. He notes that a central bank that proclaims an effort to depress asset prices makes few friends and many enemies. Thus, aside from the legitimate substantive reasons to treat seemingly anomalous asset-price declines and asset-price increases somewhat asymmetrically (as discussed earlier), there are significant public-relations reasons why a central bank might want to explain these actions in somewhat different terms. Indeed, even an independent central bank needs to be politically responsible through some mechanism, and it needs to maintain public support of its general policy behaviour, if not necessarily for every individual policy action. The way to deal with this issue, according to Mussa (2003) is not to focus on explaining the role of asset prices in the conduct of monetary policy, but rather to emphasize the responsibility of monetary policy to contribute to general macroeconomic stability. If asset prices appear to be behaving in an anomalous manner, but this behaviour has no meaningful effect on the macroeconomy, then monetary policy should not be concerned. Of course, tying monetary policy to the broad objective of preserving macroeconomic stability will not necessarily make monetary policy popular[178] (Mussa (2003), p. 49-50).

The inability to identify asset price bubbles ex ante should be sufficient reason for policymakers to be cautious about taking pre-emptive actions to deflate an asset-price bubble according to Krozner (2003), while the inability to identify asset price bubbles ex post not only reinforces this cautious approach but also "should cause policymakers to take pause about whether the rhetoric of asset-price bubbles is a useful concept for policy discussions" (Krozner (2003), p. 7). In order to answer the question of what other policies should the policymakers pursue in the light of the above inability to deflate a bubble, one should delve into the source of an asset price bubble, namely the mispricing of assets. A policy implication is that better information, easily accessible to all investors makes bubbles more difficult to form and to be sustained (Kroszner (2003), p. 7-8). He notes that "when a price seems to outstrip fundamentals, investors logically ask whether it is a bubble or whether they do not have access to important information about fundamentals, [therefore] it is

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[178] People tend to like an economic boom, at lest up to the point that it begins to translate into higher consumer price inflation. When memories of relatively high inflation were fresh and inflation itself tended to begin to accelerate at a somewhat earlier stage of an economic expansion, it was possible for central banks to point credibly to the threat of reviving the demon of inflation as justification for timely tightening of monetary policy. However, if monetary policy remains generally successful in keeping consumer price inflation subdued and the tendency for inflation to give early signs of acceleration further ameliorates, people may come to doubt that there really is a demon. Then, it may well become more difficult for central banks to persuade a sceptical public of the need to restrain a popular economic boom. In this situation, escalations of asset prices may become a more valuable signal and symptom of growing macroeconomic imbalances that warrant a monetary policy response. If so, central banks will simply have to face up to the fact that their fundamental task is not to maximise their popularity. For evidence on the fact that banks play a special role in the financial system because of their capacity to monitor borrowers and reduce problems generated by information asymmetries (see, for example, Battacharya and Thakor (1993)), (Mussa (2003), p. 50)

important that information is available not only to selected individuals, but to the general public"[179] (Kroszner (2003), p. 7-8).

Since several causes may trigger different asset-price booms, which, in turn, may lead to different consequences, the appropriate monetary policy response to an asset-price boom is not a single type. Such and observation led economists to point out (see Richards and Robinson eds. (2003)) that there other types of policy may be relevant to counter the asset-price booms, such as tax and regulatory policies. Carmichael (2003) stresses that in the case of asset-market developments implying a rising level of risk in the financial system the financial regulator, in particular, must be concerned and make assessment of whether the capital held by banks needs to be increased. It is needless to say, however, that regulators need not be more apt to identify asset-price bubbles than others. De Brouwer (2003) also notes that monetary policymakers must be cautious of the fact that interventions in an effort to limit speculative activity in one class of assets may not simply move the problem elsewhere.

The clear policy lesson to be drawn from this literature is the importance of improving transparency. Better public information diminishes agency problems, especially by reducing information asymmetry and uncertainty about the economic environment. With more accurate and complete information, heightened competition among intermediaries would enhance incentives to align the intermediaries' interests

[179] Krozner (2003) notes that academic work suggests particular avenues through which public information can prevent bubbles from forming as for example, Allen and Gale (2003) building on their earlier work identify the agency relationship as a key transmission mechanism in the formation of bubbles. He remarks that the agency problem arises from an asymmetry of information (Krozner (2003), p. 8).

with those of their clients, individual investors, and, therefore, lead to a more successful assessment of the risks undertaken with their clients' funds. Thus, as Krozner (2003) suggests better disclosure of information and clearer rules are warranted (Kroszner (2003), p. 9).

Finally, there is broad consensus, expressed, for example in Richards and Robinson eds. (2003) (see also ECB (2005) and the discussion in Chapter 5) that even though policy-makers should not attempt to target asset prices, they should also not ignore them. As suggested by Lowe (2003) monetary policymakers must focus on whether credit and asset-market developments create a substantially high financial-system risk, as well as broader macroeconomic risks.

The important issue then remains, according to Richards (2003), of the appropriate reference of an inflation-targeting regime to these risks, given the general objectives in terms of inflation and economic activity. The challenging issue is that the risks created by asset-market developments tend to be low-probability, medium-horizon events that cannot be easily included in standard short-term forecasts. Richards (2003) contends that "the risk of a substantial asset-price correction may, in fact, be sufficiently low or hard to quantify as to be excluded from any central forecast, particularly at a horizon of only one or two years, but that does not mean that it can be ignored. These considerations, rather, highlight the need for monetary policy to maintain a medium-term perspective and to take into account an assessment of risks to the outlook, not just the central forecast" (Richards (2003), p. 6).

## 6.7 Concluding Remarks

Asset price bubbles are an especially difficult topic. They tend to be difficult to explain in part just as history is difficult to explain, since a huge variety of forces shapes historic events. Bubbles are also difficult to explain, relative to other historic events, since they involve a complex interaction in which people try very hard to outsmart each other.

Notably, Shiller (2003) points out the difference in approach to research on asset price bubbles by stressing that “microeconomists still rarely cite macroeconomists, economists rarely site psychologists, and academics rarely site news media stories.” Therefore, he further remarks that the research on asset-price bubbles, in general, yields fragmentary conclusions (Shiller (2003), p. 36).

Monetary policy actions affect the financial markets and the economy to a great extent. In this manner, monetary policy can be too blunt an instrument to respond only to a relatively narrow segment of asset markets. It is, thus, contended that for monetary policymakers to defuse (at least a significant part of the) volatility in asset prices using monetary policy should be neither feasible nor desirable. However, beyond the accepted general relevance of asset prices as macroeconomic indicators, Mussa (2003) suggests that even though it does not seem practical to link adjustments in monetary policy in some mechanical way to movements in asset prices (as for example including them in a variant of an augmented Taylor rule), only in exceptional times and circumstances, they should exert a special influence on the conduct of monetary policy (Mussa (2003), p. 42, 44).

Because of their potential effect on price and financial stability developments in asset prices are a serious cause of concern for monetary policymakers. Nevertheless, at least two main reasons stand out against the introduction of asset prices into a central bank's monetary policy reaction function. These reasons are that, asset prices are difficult to determine scientifically, and if they were to constitute indicators of monetary policy, since they are highly volatile, they would render the implementation of sound monetary policy very difficult. As Trichet (2003), for example, emphasizes, other than using monetary policy the functioning of the financial system can be improved through measures enhancing market transparency and reducing herding behaviour. Propositions include improvements on regulatory, accounting measures, tax rules and regulations, as well as of codes of good conduct and good practices.

This chapter presented that a hotly debated issue for both policymakers and academics has been the relationship between asset prices and monetary policy. It does not seem to be disputed that a sharp decline in asset prices can be disruptive. In addition, for example, Bernanke (2000), and Kohn (2006) point towards a broad agreement that failure to deal decisively with financial system weakness was a major policy mistake. Yet, Gaspar and Kashyap (2006) remark that the issue of what to do when faced with a large increase in either equity prices or house prices still remains contentious.

On this issue, Hunter, Kaufmann and Pomerleano (2003) cluster the potentially vital messages to monetary policymakers in their effort to devise a monetary policy plan of action, so as to protect against asset-price bubbles or mitigate their impact. They point out the following general conclusions:

• It is very difficult for monetary policymakers to identify asset price bubbles when they develop, due to constraints of imperfect information, the downside risks of misusing instruments, limited effectiveness of policy instruments, and time constraints.

• Even though crises follow a great number of asset-price bubble collapses, not all cases of the latter result in crises that create financial system instability. Financial systems, which operate (before the development of a bubble) under solid supervisory and regulatory institutions and macroeconomic stability have proven to be more resilient to the unwinding of a bubble than systems not having the above features. In this respect, asset-price bubbles followed by costly crashes tend to be more frequent in emerging, rather than developed, economies where financial markets tend to be more opaque, supervision and regulation are rather poor, and lending is mainly based on collateral in stead of expected cash flow projections (as a result primarily of poor accounting standards).

• Weak macroeconomic policies, insufficient policy transparency and micro-structural weaknesses encouraging the development of asset-price bubbles, tend to exist in economies that experience crashes that last longer, bear higher costs and are more destabilising. It, thus, points towards the establishment of an effective prudential regulatory regime to safeguard the financial system from the adverse consequences of a crisis, rather than attempts of an appropriate and prompt identification of asset-price bubbles.

• Potential agency problems and information asymmetries are minimised by transparency. It is also important to enhance the development and enforcement of accounting and auditing standards, including the frequency and means of dissemination and the quality of disclosure.

• More diversified financial systems tend to spread risks and counter the consequences of the unwinding of bubbles better than less diversified ones. It is, thus, important to encourage the development of risk-transfer instruments, like index funds, securitized assets, stock borrowing, lending, and short-selling regimes, and regulated futures and derivatives markets, in order to allow for heterogeneity in investors' attitude and enable investors' hedging against asset-price bubbles.

• Since solid regulatory and supervisory institutions tend to be the 'best line of defence', it is important for a central bank to maintain its credibility and reputation in executing its core function of preserving macroeconomic stability (Hunter, Kaufmann and Pomerleano (2003), p. 25).

Historical episodes justify the challenges bubbles in asset prices pose to monetary policymakers, since they tend to evolve quickly and produce very high costs to the overall economy when they burst. However, as they are difficult to recognise promptly, they tend to be identified only ex post. Nevertheless, even though research provides several different tools enabling the early identification of asset-price bubbles, it is still vital for monetary policymakers to monitor movements in asset prices in an attempt to preserve consumer-price stability over longer horizons.

# PART THREE

# A GAME-THEORETIC MODEL OF MONETARY POLICY UNDER RISKS TO FINANCIAL STABILITY

# CHAPTER 7

# THE CASE OF *COMPLETE* INFORMATION[180]

## 7.1 Introduction

By the mid-1980s, it was established that central banks should be responsible for controlling inflation, and over the next few years, progressively, most central banks in the developed world were made independent. Subsequently, the fight against inflation has proved successful, at socially acceptable costs. However, the ongoing financial crisis has focused attention on the central banks' more historic role. It has been questioned "how well central banks have discharged their twin duties as the guardians of financial stability and as defenders of price stability" (*The Economist*, 20th Oct 2007, Special Report, p. 3).

More recently, the debate has been on whether price stability is sufficient to foster financial stability, or whether a trade-off exists (at least in the medium-run). If the latter is the case, it is questioned whether monetary policy should exercise its influence in order to address asset price bubbles when they grow (before forecasts to inflation are affected) or counter their effects after they unwind. The conventional view accepts that asset price misalignments are difficult to recognise and that central banks should act just against the adverse consequences of a bubble unwinding (see

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[180] This chapter is based on joint work with Mr. Richard Barrett and Professor Somnath Sen. We would like to thank Professor John Fender, Professor Indra Ray and participants at the Public Choice Society conference, held in San Antonio, Texas, in March 2008, for helpful comments. All the remaining errors are mine.

eg. Greenspan (2002), Bernanke and Gertler (2001), Bean (2004)). The opposite view advocates the merits of the so-called ‘pre-emptive’ monetary policy conducted as financial imbalances accumulate with the aim to forestall the potential adverse consequences in the aftermath of a crisis, especially since low and stable inflation is thought to mask threats to the economy that make the financial system more vulnerable and which cannot be captured by an output gap measure (see eg. Borio (2005), Borio and Lowe (2002), Bordo and Jeanne (2002), Cecchetti et al. (2003), White (2006)).

In line with the above debate, we address the second view as a policy option and evaluate pre-emptive monetary policy when a central bank considers financial stability as an explicit policy objective, yet replacing the output gap. Accepting that the effect of the policy instrument is transmitted through the financial sector, a central bank recognises that respective reactions from the latter can either enhance or hamper the implementation of monetary policy to the real economy. To capture that aspect – (to our knowledge) in contrast to the extant literature – we construct a simple model of the strategic interaction between a central bank and the financial sector in a closed economy.

Following the tradition that started with Barro and Gordon (1983a), we represent the central bank and the financial sector as playing a monetary policy game, yet in a context that accounts for the currently uncontested view that price stability promotes economic stability in the medium to long-run (see eg. Bernanke (2006), and Jordan (2006)) and, thus, not giving rise to the presence of an inflation bias (at least not in the same fashion) and the particular case of time inconsistent monetary policy that arises from it. We examine monetary policy both under commitment to an instrument rule and under discretion, motivated, principally, by the concluding remarks in Bordo and Jeanne (2002) that “financial stability presents a direct challenge to the rule paradigm because it may require occasional deviations from simple rules – i.e. policies that are sometimes based in a complex way on discretionary judgment”. To our knowledge, the literature in favour of pre-emptive monetary policy against financial instability (as presented in Chapter 6) puts forward the conclusion that the monetary authorities should exercise their policy with more flexibility and over longer policy horizons. On the contrary, our analysis concludes that when a central bank addresses financial stability as a main and systematic component of its decision making process, namely as an explicit monetary policy objective, then policy yields better results in terms of controlling inflation, anchoring inflation expectations and imposing more prudence to the operation of the financial sector when conducted under commitment to a rule. Therefore, we contend that the contribution is twofold. Namely, in terms of the method used and in terms of the results proposed.

The organization of the chapter is as follows: the next section 7.2 presents the method used in the analysis and the assumptions made. Section 7.3 describes the model and section 7.4 the outcomes that arise in equilibrium which are followed by a discussion in section 7.5. Then in section 7.6, we extend the model by addressing bad debts in the real and the financial sector, incorporating, thus, the effect of default on loans issued by the financial sector on the latter’s profitability. Section 7.7 states the implications of our analysis for monetary policy-making and section 7.8 is the conclusion. For comparative reasons we, finally, include an Appendix where we work out the principal model in terms of a central bank that does not conduct pre-emptive policy but faces the traditional objectives of price and output-gap stability.

## 7.2 Preliminaries (method and assumptions)

We assume that a non-cooperative game is played between a central bank, B, and a financial sector, S. This implies that players are not able to make binding agreements (or any sort of other commitments), except for the ones which are explicitly allowed by the rules of the game (van Damme (1983), p. iii). Each player is assumed to be "rational" in the sense that they are aware of the alternatives presented to them, form expectations about any unknowns, have clear preferences, and choose their actions deliberately after some process of optimisation (Osborne and Rubinstein (1984), p. 4).

S chooses a level for the long-term nominal interest rate, *R*. In a simplified view of reality the long-term nominal interest rate is perceived as the price of a main product offered by the financial sector (namely loans issued to the real sector). The financial sector is modelled in the aggregate, as 'one agent' that represents the consolidation of the financial intermediaries (i.e. financial firms and institutional investors) which operate in purely competitive markets. Such a seemingly strong assumption is deemed necessary for modelling purposes. Nevertheless, it seems to be justified by the fact that strong competition between financial-market participants makes the 'leaders' in the markets (for example financial firms with considerably high levels of capitalisation) not prone to maintain their identity as price-makers (with respect to the pricing of financial assets) over a long horizon. The increasingly rapid dissemination of information in addition to the speed characterising financial transactions makes it considerably difficult for financial firms to maintain competitive advantages (which are known to give the ability to a firm to act as a price-maker) at least without an incessant effort of differentiation in the product offered. A second reason is that financial markets have proven to act almost in unison at times of turbulence. Therefore, a crisis' intensely rapid contamination of financial-market participants can give credence to our view of the financial sector as acting under pure competition. For the above reasons we also abstract from modelling S with respect to the behaviour of a representative agent instead.

S increases welfare when its survival is guaranteed and profits are increased. As explained in detail in the following sections profits are perceived in terms of the margin between the rates charged on illiquid and relatively liquid financial assets (the former represented by loans to the real sector and the latter by interbank-market funds). S's 'survival' implies a level of profits low enough to cover the costs of firms' entering and operating in the sector. In accordance to the theory on pure competition, at this lowest level of profits the number of firms entering the market and those ceasing operation (referring in this model to bankruptcy rather than insolvency) are up to a minimum acceptable number.

B controls inflation by choosing the degree of accommodation of the shocks to inflation, which is termed as *x*. Therefore, the choice variable of B is *x*. The central bank, B, is assumed to be independent and solely responsible for monetary policy. The instrument it uses is assumed to be a short-term nominal interest rate, interpreted as the overnight interbank-offered rate, which can be described in terms of *x*. In the interbank-funds market the central bank is essentially a price-maker, and while financial firms resort to this market in order to satisfy their demand for liquidity, the central bank's policy choice influences the behaviour of the financial sector.

The model refers to a closed economy (therefore, exchange rates are not considered as asset prices) with an implicit real sector (thus, only financial assets are under consideration). Since the behaviour of the real sector is not modelled, consumption and investment decisions made by firms and households are reflected in the workings of the financial sector that allocates funds from savings to investment projects. The model, further, presents no role for a government. The latter assumption implies the absence of fiscal policy considerations and, also, that government securities[181] are traded through financial intermediaries in secondary markets, which are, thus, encompassed in the sum of the financial securities.

Time is discreet and *t* denotes a point in time. The information that each player faces is complete, in that the full description of the game is common knowledge and perfect, in that when each player has to make a move they know exactly what happened in previous moves. The game is sequential, in that the strategic interaction between the two players takes place in a sequence of moves, one by each player. S makes the first move, then, B moves second and ends the game. Play in a sequence of moves arises from the presence of a second-player advantage, which the second player, B, would otherwise give-up if the strategic interaction between the two

[181] For arguments for and against the purchase of government bonds, see respectively Oda and Okina (2001) and the comment by Beebe (2001), especially p. 366.

players were simultaneous. This advantage stems from the control B has over inflation, conducting monetary policy so as to counter inflation shocks, and from the fact that S's profits are bound in long-term contracts that cannot rapidly change in response to new information.

## 7.3 The Model

### *7.3.1 The economy*

A simplified structure of the economy is modelled through the following three equations:

$$\pi_t = E\pi_t + \varepsilon_t - x_t \quad \text{for} \quad \varepsilon_t \sim \text{iid } N\left(0, \sigma_\varepsilon^2\right) \tag{7.1}$$

$$x_t = \frac{r_t - r^*}{\beta}, \qquad \beta > 1 \tag{7.2}$$

$$i_t = r_t + \pi_t . \tag{7.3}$$

Briefly, (7.1) describes inflation. Inflation, $\pi$, is a linear function of, first, the financial sector's inflation expectations, $E\pi$, formed at $t = 0$ with respect to all the available information and, second, an inflationary shock, $\varepsilon$, that is observed at $t = 1$, can be positive or negative and is assumed to follow a white noise (stochastic) process. The equation does not give rise to inflation inertia. The third term is the level of accommodation of the shock, $x$, that is achieved through monetary policy.

(7.2) captures the transmission of monetary policy to the real short-term interest rate, *r*. (7.3) describes what is known as the Fisher identity (termed after Fisher (1896)), the (approximately) one for one adjustment of nominal interest rate, *i*, to the level of inflation (in a steady state). This equation is used in a way that describes actual inflation and the ex post real interest rates.

*(i) Inflation equation*

In greater detail, equation (7.1) is similar to the inflation equation used in Blanchard and Fisher (1989) that models shocks to inflation as any deviation of *rational expectations* of inflation from its actual level, namely as: $\pi - E\pi = \varphi\varepsilon$ (quoted in McCallum, 1997). In our framework, however, since the real sector is exogenous, $E\pi$ denotes the financial sector's expectations. However, the inflation expectations of the real sector that shape its investment and saving behaviour can be supposed to be the same as the expectations of inflation of the financial sector. Expectations are formed rationally[182] and we assume that the full effect of the shock $\varepsilon$ is transmitted to inflation (i.e. $\varphi = 1$). As the behaviour of the real sector is implicit in this model, decisions about consumption and investment are reflected in the variations in $E\pi$ and their effect to inflation.

The *shock to inflation* reflects any variability in inflation that is not comprised in expectations and, therefore, it stems from new information about the economy. The *monetary response* to a shock to inflation, the term *x*, is optimally chosen in equilibrium. In choosing *x*, B can control the outcome for the rate of inflation. The

[182] Rational expectations are defined in the standard manner, in that $E_{t-1}\pi_t$ is equal to the mathematical expectation of $\pi_t$ conditional on variables observable at time *t*-1 (including past data).

way B actually controls inflation is not modelled explicitly. However, B uses the short-term interest rate *i* as its instrument and equation (7.2) gives a simple functional form of the monetary transmission. Therefore, the actual rate of inflation at time *t* is determined by $E\pi$ formed at $t$-1, $\varepsilon$ realised at some time between $t$-1 and $t$, and $x$ applied after the observation of $\varepsilon$, at $t$.

By taking expectations in equation (7.1) we obtain

$$Ex = 0, \tag{7.4}$$

where $E$ is the expectations operator.

This result shows that on average monetary policy is just neutral. This result stems from the definition of the stochastic process that the shocks are assumed to follow and from the additive effect of the shock to inflation.

The model does not incorporate any 'lender of last resort' behaviour on the part of the central bank. Such a shortfall in the model is deemed appropriate because, even though central banks are apt and willing to exercise such behaviour[183], they refrain from making any explicit mention in their official statements for fear of giving rise to 'moral hazard' in the financial sector.

[183] For instance, in the case of the ECB, Article 3.3. of the Protocol on the statute of the European System of Central Banks and of the European Central Bank states: "…., the ESCB shall contribute to the smooth conduct of policies pursued by the competent authorities relating to the prudential supervision of credit institutions and the stability of the financial system" (quoted in Buiter (2007), p. 2).

*(ii) The monetary policy effect*

To specify how the short-term rate of interest, *i*, determines monetary stance, assume:

$$x_t = F(r_t) \qquad (0 < F' < 1), \qquad (7.5)$$

where $r_t$ is the real short-term rate of interest, as in (7.2). The restriction on $F'$ means that, first, *r* and *π* are inversely related and second, that in order to raise *r* and lower *π*, it is necessary to raise *i*. We are supposing the transmission mechanism from *i* to *π* is via *r* and its effect on the real economy. A higher value for *r* encourages saving, raises the cost of borrowing short in order to fund business activity or inventories, influences sentiment and so, in various ways, increases the output gap (if the latter is negative and vice versa) and reduces *π*.

Substituting (7.3) into (7.2) and (7.2) into (7.1) shows that, given *F*, *Eπ* and *ε*, the choice of *i* determines *π*, *r* and *x*. In determining strategy, B could as equally set a target for *r*, or for *x*, as well as choose the level of its instrument, *i*.

Recalling that, from (7.4), the central bank's monetary stance is on average neutral, let

$$F(r^*) = 0, \qquad (7.6)$$

where $r^*$ can be thought of as the 'natural' real rate of interest[184].

If $r>r^*$, monetary policy is restrictive and, if $r<r^*$, it is expansionary. Therefore, by linearising (7.5) for simplicity, we assume the resulting equation (7.2):

$$x_t = \frac{r_t - r^*}{\beta} \qquad (\beta > 1)\,. \qquad (7.2)$$

Here, $\beta$ is an inverse measure of how effectively the real short-term rate of interest, $r$, controls inflation. The restriction on $\beta$ follows from the restriction on $F$ in (7.5). Since $r$ denotes the ex post real short-term interest rate it incorporates the effect of $x$.

*(iii) The Fisher effect*

Equation (3), the Fisher identity, describes, in this version, the relation between the rates of change of the ex post real interest rate, the nominal interest rate and the rate of inflation. In a steady state, where $r=r^*$, this implies the long run homogeneity of nominal variables, namely that nominal interest rates and inflation change proportionally in response to a nominal shock[185]. Out of the steady state, however, there is no longer any presumption that short-run variations in expected inflation will leave the real rate unaffected (Walsh (2000), p. 57). In the present model we use

[184] Woodford (2003), (pp. 21, 49-55) provides an analysis on Wicksell's notion of the natural real rate of interest, i.e. the rate of interest required for equilibrium with stable prices. It is also referred in the literature as the neutral or the equilibrium real rate of interest.

[185] Equation (3) is derived from the following approximation. Consider the nominal interest rate that an asset must yield if it is to give a real return of $r$ in terms of the consumption good. That is, consider an asset that costs 1 unit of consumption in period $t$ and yields $(1+r_t)$ units of consumption at $t$+1. In units of money, this asset costs $p_t$ units of money at time $t$. Since the cost of each unit of consumption at $t$+1 is $p_{t+1}$ in terms of money, the asset must pay off an amount equal to $(1+r_t)\, p_{t+1}$. Thus, the nominal return is $[(1+r_t)\, p_{t+1} - p_t] / p_t = (1+r_t)\,(1+\pi_{t+1}) - 1 \equiv i_t$, where $\pi_{t+1}$ denotes the inflation rate between $t$ and $t$+1. Because $(1+r)(1+\pi) - 1 \approx 1 + r + \pi - 1 = r + \pi$, the nominal rate of interest in discrete time is often written as $i = r + \pi$, (Walsh (2000), p. 57).

instead a relation between the ex post level of the real rate and actual inflation. The steady state in the present analysis is described by the outcome of the game if that is a (unique) perfect Nash equilibrium. The latter shows a tendency of every player not to change their behaviour (ceteris paribus).

### *7.3.2 The game – structure*

A way to describe a game can be a summary of the rules of the game by indicating "the choices available to each player, the information a player has when it is his turn to move, and the pay-offs each player receives at the end of the game" (van Damme (1983), p. 3). In this section we introduce these aspects that are necessary to define the game. The next subsection describes in detail the pay-off functions for each player. A pay-off function is the function that determines each player's pay-off from the combination of actions chosen by the players (Gibbons (1992), p.1) [186]. Then a subsection follows presenting the sequence of events in our analysis. The word 'event' is used rather arbitrarily, as it does not represent the notion of 'a subset of the set of states of nature' that the term 'event' usually denotes in decision theory (see eg. Mas-Colell et al. (1995), Chapter 6). By describing a 'sequence of events' we rather portray every occurrence that may take place in the context of the analysis at any time (in this fashion following Walsh (2000), p. 328). In this way, we present the

[186] The term 'pay-off function' is common in game theory while in economics the term 'objective function' is more commonly used. An 'objective function' is associated with an optimisation problem and it determines how good a solution can be to the pertinent agent or agents. Since each player in the game faces an optimisation problem with respect to the other player's optimisation problem, both terms can be used.

information each player has when it is his turn to make a move. Finally, a compact description of the game is given in the last subsection.

*(i) Objective functions*

$R$ is competitively determined. The welfare of S (the consolidated, competitive, financial sector) increases with profits. Through competition expected profits of S are driven down to a minimum level that makes the risk of non-survival just acceptable.

We model the profitability of S in terms of a loan issued (to the real sector) over a two-period horizon. The rate charged on this loan, $R$, constitutes income earned on every period the loan is serviced. In order to finance the loan the financial sector needs funds in order to meet its liquidity needs (or operating costs) during each period of the loan. The charge on these funds each period, is the per-period level of nominal short-term interest rate, $i_t$. Competition among investment projects (affecting $R$), as well as in the interbank market (affecting $i_t$ on every period) will determine the profit 'margin'.

We consider three points in time, $t$ = 0, 1, 2. Let $i_0$ be the short-term rate of interest at $t$=0, and $i$ the short-term rate of interest at $t$=1[187]. Assume $i_0$ (but not $i$) is known to S when S chooses the long-term rate of interest, $R$, at $t$=0. At $t$=2, S obtains profits per unit of currency as:

$$P = (1+R)^2 - (1+i_0)(1+i). \tag{7.7}$$

[187] For simplicity we exclude subscript 1 throughout the analysis.

$P$ in (7.7) being positive implies that the efficient market hypothesis does not hold (see Shleifer (2000) for a detailed account) and, therefore that the long-term rate is not the sum of future short-term rates. Equation (7.7) is constructed using a simple compounding-interest formula. It gives the spread between the income earned on 1 unit of currency after two periods and the income paid-out on 1 unit of currency over two consecutive periods. This margin is assumed to measure the operational profits of the financial sector.

For the sake of simplicity, and because nothing essential is involved, the following linear approximation is used:

$$P = 2R - i_0 - i\,. \tag{7.8}$$

Taking expectations in (7.8), and using (7.1), (7.2), (7.3), (7.4) S's expected profits can be described as:

$$\begin{aligned} EP &= 2R - i_0 - Ei \\ &= 2R - i_0 - r^* - E\pi. \end{aligned} \tag{7.9}$$

We assume that competition drives the expected value of profits as in (7.9) to a minimum level, which we term $Q$, at which all the firms operating in S can only cover their operating costs. $Q$ is the level of expected profits at which the market finds the chances of a number of firms operating in S going bankrupt just acceptable. It is illustrative to view $Q$ as a safety-net to the financial sector. If expected profits fall below this level then the number of financial firms that may go bankrupt is high enough to create instability in the sector.

From (7.1), (7.2), and (7.3) we can describe (7.8) as follows:

$$P = 2R - i_0 - r^* - E\pi - (\beta - 1)x - \varepsilon . \tag{7.10}$$

As is evident from (7.10), $P$ varies with $x$ and $\varepsilon$. Therefore, it is appropriate to define a minimum level for expected profits in terms of the variability of $P$. Choosing from the measures of dispersion of a distribution of a random variable over its population mean we contend that the standard deviation is the most convenient one to use. The standard deviation in contrast especially to the variance is a useful measure of spread of a distribution in part because it is mathematically tractable.

Describing, thus, $Q$ in terms of the variability of $P$, we model it as a function of the standard deviation of $P$. In detail, let $\sigma_P$ denote the standard deviation of $P$, the profits obtained by S, then

$$Q = k\sigma_P \qquad (k > 0). \tag{7.11}$$

Coefficient $k$ in (7.11) describes any structural features of the financial sector affecting its competitive level of profits, like administrative costs, psychological factors, or the presence of economies of scale. Since by construction $Q$ is positive, as well as $\sigma_P$ is by definition, $k$ is assumed to be positive.

As the variability in S's profits in this model stems from the monetary policy reaction, $x$, and the shock to inflation, $\varepsilon$, letting 'var' denote variance, we note, from (7.1), (7.2), (7.3), (7.4) and (7.8), that:

$$\begin{aligned} \operatorname{var}(P) &= \operatorname{var}(i) \\ &= \operatorname{var}(r+\pi) \\ &= \operatorname{var}\left[(\beta-1)x+\varepsilon\right]. \end{aligned} \tag{7.12}$$

We assume competition drives the expected value of $P$ to $Q$ as in (7.11), so the assumption is for:

$$\begin{aligned} EP &= Q \\ &= k\sigma_P \qquad (k>0). \end{aligned} \tag{7.13}$$

Therefore, (7.13) determines the optimal level of $R$ under competition, as a function of $i_0$, $r^*$, $E\pi$, $x$, and $\varepsilon$.

Turning to the objective function of the central bank, B, we define B as choosing $x$ by optimising over the following utility function:

$$U = -(\pi-\pi^*)^2 - \alpha(P-P^*)^2 \qquad (\alpha>0), \tag{7.14}$$

where $\pi^*$ and $P^*$ are targets for the rate of inflation and profits, respectively. The central bank has two concerns: (i) the value of the currency and (ii) the stability of the financial system.

The financial stability objective is defined in terms of the level of profits in the financial sector (as in (7.8)) and a corresponding target faced by the central bank. We take a low value for *P* (with reference to the target) to mean insolvency in the financial sector, and too high a value to imply a 'bubble' in asset prices, namely the accommodation of speculative behaviour from certain financial sector participants in excess to the market fundamentals. As the financial sector is modelled in aggregate terms, the former is not desired as too low a value of *P* could even imply a collapse of the financial system, namely that a considerably high number of financial firms would seize operation. On the other hand, neither the latter is desired since the level of *P* that is justified by fundamentals is the one set as the target. The higher the level of *P* above its target the more a bubble would be accommodated causing strains in the economy and, thus, increasing the likelihood of acute economy-wide instability after the bubble collapses (as described in Chapter 5).

The traditional output gap objective, the percentage difference between actual output and output consistent with the natural rate of unemployment, is replaced by a financial stability objective. This can be justified by the scepticism expressed in recent literature about the inclusion of an output gap measure in a central bank's objective function.

Meltzer (2001) claims that "using the output gap as an objective of the central bank is problematic" since, primarily it can "arise for reasons unrelated to monetary policy actions – for example, an oil shock, reductions in employment and output resulting from provisions of the welfare state, or other real events". He also contends that the way to overcome this problem as proposed by McCallum (2001a), namely to redefine the natural rate so as to take account of non-monetary effects, can be done in principle, but is difficult to do accurately in practice (Meltzer (2001), p. 122).

The difficulty of the precise measurement and the lack of agreement on the value of the natural rate of output and the related problems posed to policymakers have been stressed, among others, by McCallum (2001b), Orphanides (2003), Orphanides and Williams (2004) and FRB of Cleveland ed. (2000).

In addition, while Jordan (2006) claims that real rapid growth and low unemployment cannot cause inflation and that there is no trade-off between inflation and employment, Bernanke (2006) and Poole (2008) claim that price stability supports both strong growth and stability in output and employment not only in the long-run, but also in the short run.

Meltzer (2001) further points out that central banks aiming mainly and principally at price stability should not preclude concern for the cost of achieving the target rate of inflation and that this cost should appear in the objective function replacing the output gap. This implicit cost function should include the costs of maintaining or restoring financial safety or solvency, avoiding a credit crunch, or increasing unemployment (Meltzer (2001), p. 122). The above helps motivate the use of (7.14) as the objective function of B.

Furthermore, we work through the model using $x$ as B's choice variable. Even though the use of $r$ or $i$ instead could have been equivalent, it is deemed rather inappropriate because the actual strategic action of a central bank is the 'level' of control over inflation, while changes in the policy rate as a lever on an array of interest rates are the workings of the instrument employed.

Finally, as a caveat we refer to Eichberger's (1993) remark that the common practice in economics is to take the curvature of an expected utility function to represent the corresponding agent's attitude towards risk, while "in game theory it is usually assumed that *pay-offs represent the subjective evaluation of the outcome of a play by the agent* (emphasis not in the original text)[188]. This means that the pay-offs are assumed to reflect a player's risk attitudes. Consequently, attitudes to risk are rarely explicitly considered in game-theoretic analysis" (Eichberger (1993), p. 22). Hence, we refrain from making such considerations in the current analysis.

### *(ii) The sequence of events*

The strategic interaction between the two players takes place between points in time $t$ = 0 and $t$ = 1. Before the interaction takes place, at $t$ = -1, B sets a target for inflation, $\pi^*$, with the aim to anchor S's expectations of inflation around the target, and a target for the level of profitability of S, $P^*$. $P^*$ reflects the level of $P$ that the central bank

[188] In game-theoretic models individuals often have to make decisions under conditions of uncertainty referring to the objective parameters of the environment, imperfect information about events that happen in the game, actions of the other players that are not deterministic, or even the reasoning of the other players. To model decision-making under uncertainty, almost all game theory uses the theories of von Neumann and Morgenstern (1944) and Savage (1954). That is, if the consequence (or pay-off) function is stochastic and known to the decision-maker (i.e. for each action $a \in A$ the consequence $g(a)$ is a lottery (probability distribution) on C, the set of possible consequences of actions) then the decision-maker is assumed to behave as if he maximises the expected value of a (von Neumann-Morgenstern utility) function that attaches a number to each consequence. If the stochastic connection between actions and consequences is not given, the decision-maker is assumed to behave as if he has in mind a (subjective) probability distribution that determines the consequence of any action. In this case the decision-maker is assumed to behave as if he has in mind a "state space" Ω, a probability measure over Ω, a function $g : A \times \Omega \to C$, and a utility function $u : C \to \mathbb{R}$ ; he is assumed to choose an action α that maximises the expected value of $u(g(a,\omega))$ with respect to the probability measure (Osborne and Rubinstein (1994), p. 4).

views as sufficient to guarantee S's survival and proper functioning, in terms of channelling funds from savings to investments. B also defines and announces a positive level for $\alpha$, the weight assigned on the financial stability objective, denoting the preferences of the central bank for the stability of the financial sector. The level of the short-term nominal interest rate that resulted from past policy, i.e. $i_0$, and the level of the 'neutral' real interest rate $r^*$, are, also, predetermined and known to both players at $t$ = -1, as well as the form of the monetary policy rule, which is set and announced at $t$ = -1. The level of $Q$, at which S finds the chances of bankruptcy of some firms in the sector just acceptable, is known to both players at $t$ = -1, before the start of the game. In particular, as $Q$ is a function of the monetary policy reaction $x$, it is its functional form that is known before the interaction takes place.

At $t$ = 0, B is confronted with two alternatives, namely (i) to commit to the rule for monetary policy or (ii) to ignore the announced rule and, eventually, act with discretion after a shock to inflation has been realized and observed. If B commits to follow the rule, then it announces the corresponding $x$ as a function of the distribution of shocks to inflation $\varepsilon$ prior to S's making a choice of $R$. Therefore, at $t$ = 0, B, first, sets $x$ with respect to the rule and the anticipated choice of $R$ by S, S forms its expectations for inflation $E\pi$ anticipating B's behaviour and then at $t$ = 0, S makes a choice of $R$. The crucial issue in the case of B's commitment to a rule is that B makes the announcement before S makes its strategy-choice. At $t$=1 after the realisation of the shock to inflation $\varepsilon$ B applies $x$ of the level determined by the rule.

If, at $t$ = 0, B chooses not to follow the rule and act with discretion, then after the shock to inflation, $\varepsilon$, is realised (sometime between points in time $t$ = 0 and $t$ = 1) it defines $x$ at $t$=1 on a discretionary basis (i.e. by maximising its objective function in actual rather than expected terms). Defining $x$ is equivalent to defining $r$ or $i$. Furthermore, $E\pi$ are determined with respect to equilibrium behaviour in each case and at $t$ = 1 the actual level for $\pi$ is realized.

At $t$ = 0, S determines $R$ competitively by setting its expected profits $EP$ to equal $Q$. Therefore, $R$ is a function of $E\pi$ and $x$. Under complete information, S is informed about B's behaviour, being either commitment to the announced rule or not, when determining a level for $R$. Therefore, in essence we model two games of complete information, one for B committing to a rule and another for B acting with discretion. As both $E\pi$ and $x$ assume different levels under the two forms of policy, thus affecting $R$, at $t$ = 0 S is, actually, confronted with the choice either to believe and anticipate the announced monetary policy rule, and choose the competitive level of $R$ ($R_r$), in one game, or not and choose the pertinent competitive level of $R$ ($R_d$), in the other game.

We, further distinguish between two cases for B's target for financial stability, namely for $P^*=Q$ and for $P^* > Q$. Since central banks care for the safety and smooth functioning of the financial sector they tend to be either more prudent than the financial system participants (the case for $P^* > Q$) or willing to let the markets function at their own pace (the case for $P^*=Q$) . Therefore, we do not consider the case of B choosing $P^* < Q$.

Figure 7.1 below gives a graphic representation of the sequence of events in our model.

***Figure 7.1: The sequence of events***

| $t$ = -1 | $t$ = 0 | $t$ = 1 | ($t$ = 2) |
|---|---|---|---|
| $i_o$, $r^*$ | $x_{rule}$ | $\varepsilon$ | $P$ |
| $\pi^*$, $P^*$, $\alpha$ | $E\pi$ | $x_{disc}$ | $U$ |
| $Q$, $\beta$ | $R_r$, $R_d$ | $r$, $i$ | |
| *Rule for x* | | $\pi$ | |

A point in time $t$ = 2 is used for modelling purposes, as it is necessary for the definition of a long-rate that is earned after two periods.

Throughout the analysis the subscript '$d$' denotes the outcomes in the first game $\Gamma_1$, when B is acting with discretion, and '$r$' the outcomes in the second game $\Gamma_2$, when B is following a rule.

### *(iii) Game description*

A compact description of game $\Gamma_1$ is as follows:

[1] B expresses the preference to conduct monetary policy with discretion upon receipt of new information at any time.

[2] $E\pi$ are formed rationally.

[3] S chooses $R$ with respect to $E\pi$ and discretionary monetary policy.

[4] B receives information about the choice made by S

[5] B observes the shock to inflation $\varepsilon$.

[6] B chooses $x$ with respect to $R$ and $E\pi$.

In turn, a compact description of game $\Gamma_2$ is as follows:

[1] B commits to a certain kind of a rule for $x$

[2] $E\pi$ are formed rationally

[3] S chooses $R$ with respect to $E\pi$ and the monetary policy rule.

[4] B receives information about the choice made by S

[5] B observes the shock to inflation $\varepsilon$.

[6] B chooses $x$ with respect to $R$ and $E\pi$.

## 7.4 Equilibrium Outcomes

The outcome of each game is derived using a simple optimisation method. We derive Nash equilibria in that players are assumed to behave optimally with regard to their beliefs about their opponents' behaviour, and in equilibrium these beliefs have to be correct (as in Nash (1951)). They are also sub-game perfect equilibria in that players carry out their planned strategies without error (namely that no strategy will ever be played with zero probability)[189] in every sub-game identified. Each game has two sub-games, one that starts at $t$=1 with the choice of $x$ from B, and one that starts at $t$=0 with the choice of $R$ from S. Since information is complete and perfect in both games, they are solved using backwards induction.

### 7.4.1 *The case of monetary policy under discretion ($\Gamma_1$)*

Choice of $x$

It is convenient and inessential as stated above, to regard B as choosing $x$ rather than $i$, on observing $E\pi$, $\varepsilon$, $i_0$, $r^*$, $\beta$ and $R$. Substituting from (7.1), (7.2), (7.3) and (7.10) into (7.14):

$$U = -\left(E\pi + \varepsilon - x - \pi^*\right)^2 \\ -\alpha\left(2R - i_0 - r^* - \beta x - E\pi - \varepsilon + x - P^*\right)^2 . \tag{7.15}$$

Differentiating (7.15) with respect to $x$ and equating to zero:

$$E\pi + \varepsilon - x - \pi^* + \alpha\left(\beta - 1\right)\left(2R - i_0 - r^* - \beta x - E\pi - \varepsilon + x - P^*\right) \\ = 0$$

Since in equilibrium $EP$=$Q$, and using (7.9), we get

[189] This supplements the assumption of Nash equilibrium (in each sub-game) that where a player's strategy is optimal, Nash equilibrium is reached only if the other players follow exactly their equilibrium strategies. The latter assumption renders a player's strategy chosen in equilibrium suboptimal after the slightest deviation (eg. a small error) of the other player (Eichberger (1993), p. 111).

$$\begin{aligned}&\left[1+\alpha\left(\beta-1\right)^2\right]x\\&=E\pi+\varepsilon-\pi^*+\alpha\left(\beta-1\right)\left(Q-\varepsilon-P^*\right).\end{aligned} \tag{7.16}$$

Let $$H=1+\alpha\left(\beta-1\right)^2. \tag{7.17}$$

Then, from (7.9), (7.14) and (7.15):

$$x=\frac{E\pi-\pi^*}{H}+\frac{\left[1-\alpha\left(\beta-1\right)\right]\varepsilon}{H}+\frac{\alpha\left(\beta-1\right)\left(Q-P^*\right)}{H}. \tag{7.18}$$

This is the value B chooses for $x$ under discretion. Note that $x$ tends to $E\pi + \varepsilon - \pi^*$ as $\alpha$ tends to 0 or as $\beta$ tends to 1, so in the limit, $\pi = \pi^*$. The rate of inflation equals its target value when B does not care about the profitability of the financial sector (i.e. when $\alpha$ tends to 0), and also tends to this value as the power of the instrument, $i$, goes to infinity (i.e. when $\beta$ tends to 1).

Taking expectations in (7.18), using (7.4):

$$E\pi=\pi^*+\alpha\left(\beta-1\right)\left(P^*-Q\right) \tag{7.19}$$

$$\begin{aligned}x&=\frac{\left[1-\alpha\left(\beta-1\right)\right]\varepsilon}{H}\\&=\omega_d\varepsilon.\end{aligned} \tag{7.20}$$

Note that: (i) although inflationary expectations are given when B chooses $i$, they are in fact endogenous, formed, prior to B's choice of $i$, on the basis of rational beliefs about future monetary policy. (ii) If, in particular, $P^*=Q$, then, from (7.19):

$$E\pi = \pi^* . \tag{7.21}$$

<u>Choice of *R*</u>

Let $\sigma_P$ denote the standard deviation of *P*, the profits obtained by S. We assume competition drives the expected value to $Q = k\sigma_P$, so

$$EP = Q \tag{7.22}$$

$$EP = k\sigma_P \qquad (k > 0). \tag{7.23}$$

At this level for expected profits, the market finds the chances of bankruptcy just acceptable.

From (7.9), (7.19), (7.22) and (7.23), choice of *R* is governed by:

$$\begin{aligned} Q &= 2R - i_0 - r^* - E\pi \\ &= 2R - i_0 - r^* - \pi^* - \alpha(\beta - 1)(P^* - Q) \\ R &= \frac{i_0 + r^* + \pi^* + \alpha(\beta-1)P^* + \left[1 - \alpha(\beta - 1)\right]k\sigma_P}{2} \end{aligned} \tag{7.24}$$

From (7.11) and (7.20):

$$\sigma_P = \frac{\beta}{H}\sigma_\varepsilon . \tag{7.25}$$

From (7.20), (7.24) and (7.25) we get:

$$R_d = \mathrm{A} + \frac{1}{2} k\beta\omega_d\sigma_\varepsilon,$$
$$\text{where } \mathrm{A} = \frac{1}{2}\left[i_0 + r^* + \pi^* + \alpha\left(\beta - 1\right)P^*\right] \quad \left(\mathrm{A}>0\right). \tag{7.26}$$

In choosing $R$ under discretion, which we term as $R_d$, S takes into account the effect of B's choice of $x$ on $E\pi$ and, through $\sigma_P$, on $Q$. Note that, because the financial sector is consolidated, the optimisation process is implicit rather than modelled. Informally, we suppose the choice of $R$ is optimal for individual financial institutions. In other words, because of competition, they cannot do better than adopt this value for $R$.

In $\Gamma_1$ the equilibrium $\left(R_d, \omega_d\right)$ is as in (7.26) and (7.20). As both represent unique solutions to the pertinent optimisation problems, both (7.26) and (7.20) are undominated, representing, thus, a sub-game perfect equilibrium (see eg. Eichberger (1993) for a detailed proof of the statement that "every perfect equilibrium strategy is undominated" (Eichberger (1993), p. 115), and van Damme (1987) for a comprehensive account of this point).

### *7.4.2 The case of commitment to an instrument rule ($\Gamma_2$)*

Under rules, B pre-sets the way $x$ will be determined at $t$ = 1 and, in choosing the rule, takes account of the effect the rule will have on S's choice of $R$. In choosing $R$, S takes the rule for $x$ as fixed.

We define the rule[190] as:

$$x = \omega_1 + \omega_2 E\pi + \omega\varepsilon \qquad (\omega_2 > 0). \tag{7.27}$$

The rule aims at affecting inflation by controlling S's expectations and by accommodating perceived shocks to inflation at a constant rate. The choice of a rule as in (7.27) is justified by (7.1) the equation driving inflation.

Taking expectations in (7.27), using (7.4):

$$\begin{aligned} E\pi &= -\frac{\omega_1}{\omega_2} \\ &= \omega_0. \end{aligned} \tag{7.28}$$

Thus, inflationary expectations are again endogenous and controlled by the monetary policy rule. The constant term $\omega_1$ qualifies for a definition of a degree of smoothing in the adjustment of the monetary policy instrument. From (7.27) and (7.28):

$$x = \omega\varepsilon. \tag{7.29}$$

Under the commitment of a rule B is actually making the first move by announcing and committing to a rule as in (7.28) and (7.29). Then S forms $E\pi$ with respect to (7.28), anticipates $x$ as in (7.29) and determines $R$ accordingly. Then at $t$=1 B applies $x$ as in (7.29).

[190] This is an instrument rule since from (7.3), equation (7.27) can be written as a rule for the short-term nominal rate, *i*.

Choice of *R*

From (7.9), (7.11), (7.22), (7.23), (7.28) and (7.29), *R* is now, under rules, given by:

$$\begin{aligned} &2R - i_0 - r^* - \omega_0 = Q \\ &= k\sigma_P \\ &= k\left[\left(\beta - 1\right)\omega + 1\right]\sigma_\varepsilon . \end{aligned} \qquad (7.30)$$

$$R_r = \frac{i_0 + r^* + \omega_0 + k\left[\left(\beta - 1\right)\omega + 1\right]\sigma_\varepsilon}{2}. \qquad (7.31)$$

In supposing S's choice of *R* is determined by (7.31), we take it that B is committed to the rule, and S is rational in believing the rule will be enforced.

Choice of *x*

B maximises expected utility, which from (7.14) is:

$$\begin{aligned} &EU = -E\left(E\pi + \varepsilon - x - \pi^*\right)^2 \\ &-\alpha E\left(2R - i_0 - r^* - \beta x - E\pi - \varepsilon + x - P^*\right)^2 . \end{aligned} \qquad (7.32)$$

Suppose *P** is fixed, i.e. does not, like *Q*, vary with *ω*. Substituting again from (7.28), (7.29) and (7.30) into (7.32):

$$\begin{aligned} &EU = -E\left[\omega_0 + \left(1 - \omega\right)\varepsilon - \pi^*\right]^2 \\ &-\alpha E\left\{2R - i_0 - r^* - \omega_0 - \left[\left(\beta - 1\right)\omega + 1\right]\varepsilon - P^*\right\}^2 \end{aligned}$$

$$
\begin{aligned}
&= -E\left[\omega_0 + (1-\omega)\varepsilon - \pi^*\right]^2 \\
&-\alpha E\left\{\left[(\beta-1)\omega+1\right](k\sigma_\varepsilon - \varepsilon) - P^*\right\}^2 .
\end{aligned} \tag{7.33}
$$

Differentiating (7.33) with respect to $\omega_0$ and $\omega$, and equating to zero:

$$\omega_0 = \pi^* \tag{7.34}$$

$$
\begin{aligned}
&E\varepsilon\left[\omega_0 + (1-\omega)\varepsilon - \pi^*\right] - \alpha(\beta-1)E(k\sigma_\varepsilon - \varepsilon)\left\{\left[(\beta-1)\omega+1\right](k\sigma_\varepsilon - \varepsilon) - P^*\right\} \\
&= (1-\omega)\sigma_\varepsilon{}^2 - \alpha(\beta-1)\left\{(k^2+1)\sigma_\varepsilon{}^2\left[(\beta-1)\omega+1\right] - k\sigma_\varepsilon P^*\right\} \\
&= 0
\end{aligned}
$$

$$\omega = \frac{\sigma_\varepsilon{}^2 - \alpha(\beta-1)\left[(k^2+1)\sigma_\varepsilon{}^2 - k\sigma_\varepsilon P^*\right]}{\left[1+\alpha(\beta-1)^2(k^2+1)\right]\sigma_\varepsilon{}^2} . \tag{7.35}$$

Let

$$P^* = k\theta\sigma_\varepsilon \qquad (\theta \geq 0), \tag{7.36}$$

and define:

$$\tilde{H} = 1 + \alpha(\beta-1)^2(k^2+1) . \tag{7.37}$$

Substituting (7.36) and (7.37) into (7.35):

$$
\begin{aligned}
\omega &= \frac{1-\alpha(\beta-1)(k^2+1-k^2\theta)}{\tilde{H}} \\
&= \omega_r .
\end{aligned} \tag{7.38}
$$

In $\Gamma_2$ the equilibrium $\left(R_r, \omega_r\right)$ is as in (7.31) and (7.38). Similar to the reasoning in $\Gamma_1$, since both equilibrium strategies show unique solutions to the pertinent optimisation problems in each sub-game, both (7.31) and (7.38) are undominated, representing, thus, a sub-game perfect equilibrium.

Under rules if $P^*=Q$, substituting from (7.27), (7.28) and (7.29) into (7.32):

$$\begin{aligned} EU &= -E\left[\omega_0 + (1-\omega)\varepsilon - \pi^*\right]^2 \\ &-\alpha\left[(\beta-1)\omega+1\right]^2 E\varepsilon^2 \\ &= -\left(\omega_0 - \pi^*\right)^2 - (1-\omega)^2 \sigma_\varepsilon{}^2 - \alpha\left[(\beta-1)\omega+1\right]^2 \sigma_\varepsilon{}^2. \end{aligned} \tag{7.39}$$

Differentiating (7.39) with respect to $\omega_0$ and $\omega$, and equating to zero:

$$\omega_0 = \pi^* \tag{7.40}$$

$$(1-\omega) - \alpha(\beta-1)\left[(\beta-1)\omega+1\right] = 0$$

$$\omega = \frac{1-\alpha(\beta-1)}{H}. \tag{7.41}$$

Comparing (7.40) and (7.41) with (7.19) and (7.20), noting (7.28) and (7.29), we see that, in this case, the results under rules are the same as under discretion.

The fact that B sets $P^* = Q$ indicates that it accepts the "safety net" S imposes on itself, i.e. the competitive outcome at which the levels of bankruptcy of firms in the financial sector are just acceptable. In this case, any perceived risks to financial stability are encountered almost solely by S, so long as B identifies and announces the presence of an explicit objective for financial stability ($\alpha$>0). The level of $Q$ is a function of $\omega$ and, therefore, B's concerns for financial stability are incorporated in the behaviour of S. As a consequence S's expectations of inflation are anchored to B's target $\pi$* even when B is acting with discretion. This is the case when B contends that S can impose a discipline on itself through pure competition. We contend that for the particular case of $P^* = Q$ our model yields similar results to the literature assessing pre-emptive monetary policy against financial imbalances reviewed in Chapter 6.

If B finds the level of $Q$ as too lax, it sets $P^* > Q$. Since we model B as conducting monetary policy in order to pre-empt imbalances in the financial sector that are perceived and have not yet been reflected in the relevant indicators used, which, nevertheless, carry the potential of large detrimental economy-wide effects, then by assumption B can view the discipline S imposes on itself through pure competition as insufficient. This can be interpreted as a level of $Q$ that is lower than the level B views as more appropriate. We view this case as the presence of significant risks to financial stability that B is aware of and is trying to address. Therefore, B sets its target for S's profitability $P^*$ at a level higher than $Q$.

## 7.5 Discussion

An initial evaluation of the two styles of policy determined by the equilibria as analysed in $\Gamma_1$ and $\Gamma_2$ is that commitment to a rule ($\Gamma_2$) is better than discretionary monetary policy ($\Gamma_1$) in terms of better control of inflation expectations and effectiveness of policy. Comparing $E\pi$ from (7.19) and (7.34), and for $P^*>Q$, it is evident that by following a rule as in (7.27) B can anchor inflation expectations to its target for inflation $\pi^*$.

This result in favour of the commitment to a rule is reinforced by the fact that pre-emptive monetary policy as described by our model is more effective in affecting inflation under commitment to a rule.

**Definition 1**: *Monetary policy is more effective in controlling inflation when it results in a higher level for x.*

From (7.29) Definition 1 can be expressed in terms of $\omega$, the proportion of B's offsetting $\varepsilon$.

***Proposition 1***: *For $\alpha>0$ and $\beta>1$, monetary policy is more effective in controlling inflation under commitment to a rule as in (7.27) than under discretion if and only if $P^*>Q$.*

**Proof**: On comparing $\omega_r$ in (7.38), obtained under rules, to $\omega_d$ in (7.20), which is optimal under discretion, and for Definition 1, $\omega_r \geq \omega_d$ is equivalent to:

$$\frac{1-\alpha(\beta-1)\left(k^2+1-k^2\theta\right)}{\tilde{H}} \geq \frac{1-\alpha(\beta-1)}{H}$$

$$\left[1-\alpha(\beta-1)\left(k^2+1-k^2\theta\right)\right]\left[1+\alpha(\beta-1)^2\right] \geq$$
$$\left[1-\alpha(\beta-1)\right]\left[1+\alpha(\beta-1)^2\left(k^2+1\right)\right]$$

$$1-\alpha(\beta-1)\left(k^2+1-k^2\theta\right)+\alpha(\beta-1)^2-\alpha^2(\beta-1)^3\left(k^2+1-k^2\theta\right) \geq$$
$$1-\alpha(\beta-1)+\alpha(\beta-1)^2\left(k^2+1\right)-\alpha^2(\beta-1)^3\left(k^2+1\right)$$

$$\theta \geq \frac{\beta}{H}. \tag{7.42}$$

From (7.11), (7.25) and (7.36), the result in (7.42) is equivalent to $P^* \geq Q$. Both cases give identical results, $\omega_r = \omega_d$, when $\theta = \frac{\beta}{H}$ or equivalently when $P^* = k\frac{\beta}{H}\sigma_\varepsilon$. The latter can be expressed as $P^* = k\left[(\beta-1)\omega_d + 1\right]\sigma_\varepsilon$, which is the level of $Q$ when $\omega$ is equal to $\omega_d$ as in (7.20), or in other words when $\omega_r = \omega_d$. Therefore, monetary policy is more effective under rules than under discretion if and only if $P^*>Q$. +

From the proof of Proposition 1, we can also show that under rules B can exercise more discipline to S by inducing a higher level for $Q$. Since $Q$ is a function of $\omega$ and $\omega$ is higher under rules than under discretion, then the level of $Q$ is higher in the former case driving, thus, expected profits *EP* to a higher level as well.

These results in favour of commitment to a rule in cases of monetary policy with risks to financial stability contrast the main result in the literature (as presented in Chapter 6) that calls for more flexibility in the conduct of monetary policy.

Finally, in order to evaluate the behaviour of S and B, namely whether they will actually play their equilibrium strategies when they are to take an action, we need to discuss their pay-offs in turn.

The expected pay-offs to B are computed using the following:

Substituting (7.29) into (7.32), using (7.9) and (7.22):

$$
\begin{aligned}
EU &= -E\left(E\pi + \varepsilon - x - \pi^*\right)^2 \\
&\quad -\alpha E\left[2R - i_0 - r^* - E\pi - \left(\beta - 1\right)x - \varepsilon - P^*\right]^2,
\end{aligned}
$$

$$
\begin{aligned}
&= -\left(E\pi - \pi^*\right)^2 - \left(1 - \omega\right)^2 \sigma_\varepsilon^{\ 2} \\
&\quad -\alpha\left[\left(\beta - 1\right)\omega + 1\right]^2 \sigma_\varepsilon^{\ 2} - \alpha\left(Q - P^*\right)^2.
\end{aligned}
\tag{7.43}
$$

From (7.30) and (7.36):

$$
\begin{aligned}
P^* - Q &= k\theta\sigma_\varepsilon - k\left[\left(\beta - 1\right)\omega + 1\right]\sigma_\varepsilon \\
&= k\left[\theta - \left(\beta - 1\right)\omega - 1\right]\sigma_\varepsilon.
\end{aligned}
\tag{7.44}
$$

We have, on substituting (7.44) into (7.43):

$$
\begin{aligned}
EU &= -\left(E\pi - \pi^*\right)^2 - \left(1 - \omega\right)^2 \sigma_\varepsilon^{\ 2} \\
&\quad -\alpha\left[\left(\beta - 1\right)\omega + 1\right]^2 \sigma_\varepsilon^{\ 2} - \alpha\left[\left(\beta - 1\right)\omega + 1 - \theta\right]^2 k^2\sigma_\varepsilon^{\ 2}.
\end{aligned}
\tag{7.45}
$$

In addition, for (7.29), (7.36) and for $\omega_d$ as in (7.20) and for $Q_d = k\left[\left(\beta - 1\right)\omega_d + 1\right]\sigma_\varepsilon$ the following result holds:

$$
\begin{aligned}
P^* - Q_d &= k\theta\sigma_\varepsilon - k\left[(\beta-1)\frac{1-\alpha(\beta-1)}{1+\alpha(\beta-1)^2}+1\right]\sigma_\varepsilon \\
&= k\left[\theta - \frac{\beta}{1+\alpha(\beta-1)^2}\right]\sigma_\varepsilon \qquad (7.46) \\
&= k\left(\theta - \frac{\beta}{H}\right)\sigma_\varepsilon .
\end{aligned}
$$

The expected pay-offs to S are computed using:

$$
\begin{aligned}
EP &= Q \\
&= k\sigma_P .
\end{aligned}
$$

From (7.29) and (7.30), in both games:

$$EP = k\left[(\beta-1)\omega+1\right]\sigma_\varepsilon . \qquad (7.47)$$

Let $$\phi = \frac{\alpha(\beta-1)\left(P^* - Q_d\right)}{H},$$

where $$Q_d = k\left[(\beta-1)\omega_d + 1\right]\sigma_\varepsilon .$$

We can cluster the expected pay-offs to each player, with respect to $P^* > Q$, for each of $\Gamma_1$ and $\Gamma_2$.

From (7.47), we can present the expected pay-offs to S in the four distinct cases under consideration in Table 1 below:

***Table 1: Pay-Offs to S***

| S \ B | Rules | Discretion |
|---|---|---|
| $E\pi = \pi^*$ (S believes the rule) | $A_1 = k\left[(\beta-1)\omega_r + 1\right]\sigma_\varepsilon$ | $A_2 = k\left[(\beta-1)\omega_r + 1\right]\sigma_\varepsilon + $ $+(\beta-1)\phi$ |
| $E\pi = \pi^* + \alpha(\beta-1)\left(P^* - Q\right)$ (S does not believe the rule) | $A_3$ (indeterminate) | $A_4 = k\left[(\beta-1)\omega_d + 1\right]\sigma_\varepsilon$ |

From (7.47) and for $\omega_r$ as in (7.38) we determine $A_1$. Turning to $A_2$, if S believes the rule and B acts with discretion, S perceives the pay-off to be $A_1$ but the true pay-off is $A_2$. $Q$ is determined at $t$=0 by S's beliefs about future policy (the choice of $\omega$ or $x$ at $t$=1). Since $E\pi$ differs from the level defined in equilibrium under discretion (i.e. $E\pi = \pi^* + \alpha(\beta-1)\left(P^* - Q\right)$) then $x$ in this case differs from $x=\omega_d\varepsilon$, for $\omega_d$ as in (7.20) (the level of $x$ defined in equilibrium under discretion). In particular, from (7.18), in this case $x = \omega_d\varepsilon - \phi$ . Moreover, this case does not constitute an equilibrium and, therefore, (7.4) does not hold, i.e. $Ex \neq 0$. Thus, from (7.10) the expected profits to S are:

$$EP = 2R - i_0 - r^* - E\pi - (\beta-1)Ex \, .$$

For $E\pi=\pi^*$ and $x=\omega_d\varepsilon-\phi$, $EP$ in $A_2$ takes the following level displayed in Table 1:

$$\begin{aligned} EP &= 2R - i_0 - r^* - \pi^* - (\beta-1)\phi \\ &= k\left[(\beta-1)\omega_r+1\right]\sigma_\varepsilon^2 + (\beta-1)\phi, \end{aligned}$$

$A_3$ in Table 1 is indeterminate because the rule is indeterminate in the case described. If S does not believe the rule, then it perceives $A_4$ as the true pay-off. Since B wants to enforce the rule through the optimisation process it can only determine the ratio of $\omega_1$ to $\omega_2$. Finally, from (7.47) and for $\omega_d$ as in (7.20) we determine $A_4$.

For $P^*>Q$, from Proposition 1 we have $\omega_r>\omega_d$ and since >0 and $\beta>1$, then $A_2>A_1>A_4$. Therefore, S will always believe the rule if a rule is announced and play as in the interaction described by game $\Gamma_2$. In this model S would prefer B to commit to a rule of the style proposed than act with discretion.

Table 2 below gives the expected pay-offs to B in the four distinct cases.

It is important to stress that Table 1 and Table 2 are not “pay-off matrices” of a game, since each displays expected pay-offs for each player in two different games. We only use the two tables to present our main results in a compact, illustrative way. We contend that since the two games ($\Gamma_1$ and $\Gamma_2$), different though they may be, possess several fundamental similarities, we can make comparisons in the resulting behaviour for each player created from the distinct forms of interaction.

***Table 2: Pay-Offs to B***

| S \ B | Rules | Discretion |
|---|---|---|
| $E\pi = \pi^*$ (S believes the rule) | $A_5$ | $A_6$ |
| $E\pi = \pi^* + \alpha(\beta-1)(P^* - Q)$ (S does not believe the rule) | $A_7$ (indeterminate) | $A_8$ |

From (7.45), for $E\pi=\pi^*$ and for $\omega_r$ as in (7.38) we define $A_5$ as:

$$EU = -(1-\omega_r)^2 \sigma_\varepsilon^2 - \alpha k^2 \left[(\beta-1)\omega_r + 1 - \theta\right]^2 \sigma_\varepsilon^2 - \alpha\left[(\beta-1)\omega_r + 1\right]^2 \sigma_\varepsilon^2.$$

From (7.43), for $E\pi=\pi^*$, $x = \omega_d \varepsilon - \phi$ and for $\omega_d$ as in (7.20) we define $A_6$ as:

$$EU = -\phi^2 - (1-\omega_d)^2 \sigma_\varepsilon^2 - \alpha\left\{k\left[(\beta-1)\omega_r + 1-\theta\right]\sigma_\varepsilon + (\beta-1)\phi\right\}^2 -$$
$$-\alpha\left[(\beta-1)\omega_d + 1\right]^2 \sigma_\varepsilon^2.$$

From (7.46) the formula above becomes:

$$EU = -\phi^2 - (1-\omega_d)^2 \sigma_\varepsilon^2 - \alpha k^2 \left\{\left[(\beta-1)\omega_r + 1-\theta\right] + (H-1)\left(\theta - \frac{\beta}{H}\right)\right\}^2 \sigma_\varepsilon^2 -$$
$$-\alpha\left[(\beta-1)\omega_d + 1\right]^2 \sigma_\varepsilon^2.$$

$A_7$ is indeterminate for the same reason as $A_3$ explained above.

From (7.45), for $E\pi = \pi^* + H\phi$ and for $\omega_d$ as in (7.20) we define $A_8$ as:

$$EU = -H^2\phi^2 - (1-\omega_d)^2 \sigma_\varepsilon^2 - \alpha k^2 \left[(\beta-1)\omega_d + 1 - \theta\right]^2 \sigma_\varepsilon^2 - \\ - \alpha\left[(\beta-1)\omega_d + 1\right]^2 \sigma_\varepsilon^2.$$

Comparing B's expected pay-offs in Table 2 above, we conclude that $A_6 > A_5 > A_8$. This implies that even though B does better when facing the interaction described in game $\Gamma_2$ as opposed to $\Gamma_1$, it prefers at $t$=1 to deviate from applying optimal $x$ as determined in equilibrium by the rule but act instead with discretion applying $x$ as in (7.20), the optimal outcome under discretion.

In game $\Gamma_2$ the rule is always believed under the assumption of common knowledge (of rationality), which implies in this point that B follows the rule, S knows that B follows the rule, B knows that S knows that B follows the rule and so on ad infinitum (see Fudenberg and Tirole (1991), pp. 541-547, for two equivalent definitions and a discussion of the subtle notion of common knowledge in game theory). Since the beliefs of S about B's behaviour have to be consistent with B's actual behaviour in equilibrium (as the second basic assumption for the definition of a Nash equilibrium postulates), B's choice of $\omega_d$ when S anticipates a rule does not constitute an equilibrium and, therefore, cannot be maintained in future periods.

In particular, for $P^*>Q$ and for play as in $\Gamma_2$ (which is preferred to $\Gamma_1$) the resulting policy is time inconsistent similar to the type of models of monetary policy that initiated with the work of Barro and Gordon (1983a) (see the Appendix for a presentation of our model similar to the latter for B targeting inflation and growth).

A policy is time-consistent if an action planned at time *t* for time *t*+*i* remains optimal to implement when time *t*+*i* actually arrives. Irrespective of state contingency (namely that policy can depend on the realisations of events unknown at time *t* when policy is originally planned) a time consistent policy gives rise to a planned response to new information that remains the optimal response once the new information arrives. A policy is time inconsistent if at time *t*+*i* it will not be optimal to respond as originally planned (Walsh (2000), p. 321).

Our results show that when there is substantial threat of financial instability, the central bank has sensitivity over signs of financial fragility and it is believed by the central bank that the financial sector cannot guarantee stability (since a number of financial firms that should have exited the system are still under operation to the detriment of the sector itself and the economy as a whole) the optimal policy is time inconsistent. In $\Gamma_2$, S will anticipate the announced rule for monetary policy, anchoring its expectations around the central bank's target for inflation[191]. Then for $E\pi = \pi^*$ S determines the competitive level for the long-term interest rate accordingly. If, however, B anticipates that and has an objective function that (under risks to financial stability) reveals the willingness to induce some prudence in S by setting the target for financial stability as $P^*>Q$, B will not follow the rule and apply the optimal policy under discretion instead in order to yield a higher pay-off . If the same two-period game is played again (starting straight after $t$=1), S, after learning

[191] This result stems from the forward-looking aspects of the model.

from this experience of $t$=1, will not believe the announced rule. If in game $\Gamma_2$ B deviates from the equilibrium-path and chooses $\omega_d$ instead, then when the game is repeated B cannot induce S to believe that the rule will be enforced in the next period irrespective of the fact that both players yield higher pay-offs in this case. S will expect discretionary monetary policy from B, i.e. play as in $\Gamma_1$, and, therefore, give rise to a sub-optimal outcome since in equilibrium both players receive lower pay-offs compared to the equilibrium outcomes in $\Gamma_2$.

The main policy implication of our model is that this dynamic inconsistency of pre-emptive monetary policy justifies the necessity of the commitment to a rule by the central bank in a similar fashion to the extant literature on time inconsistent monetary policy that initiated with the seminal contribution of Barro and Gordon (1983a).

Finally, our result in favour of commitment is similar to Dupor (2005) who investigates whether monetary policy should respond to movements in asset prices that are driven by irrational expectational shocks to future returns to capital and compares optimal policy under commitment and under discretion. In contrast to our setting he models the behaviour of households, firms and a central bank in a sticky price, imperfect competition model with capital accumulation and investment adjustment costs. He concludes that “lack of commitment has a much larger effect on the optimal policy response to non-fundamental asset price movements. Optimal policy under discretion generates a longer and deeper recession in terms of consumption than under commitment” (Dupor (2005), p. 747).

## 7.6 Extended Model

We extend the model to include default on loans issued by the financial sector. Such an extension seems appropriate mainly for two reasons:

a) default on loans issued by the financial sector determines the profitability of the latter, which is a main element in our model, and

b) it reinforces our argument for the substitution of the macroeconomic objective in the central bank's objective function with a financial stability objective. This is so because the decision to default on (corporate or household) debt rests with the agents in the real sector and strongly reflects the prevalent economic conditions.

As the real sector is not explicitly modelled, the levels of default, which we term as $\lambda$, are for simplicity modelled as a random variable (drawn from a population that includes elements of the structure and the behaviour of both the financial and the real sector, as well as the design and conduct of monetary policy). We assume that $\varepsilon$ and $\lambda$ are jointly independent. In particular, $\lambda$ is identically and independently distributed with a constant mean and a constant variance, $\lambda \sim \text{iid}\left(\mu_\lambda, \sigma_\lambda^2\right)$. The distribution of $\lambda$ is common knowledge, and at $t$=1 its value is realised, prior to B's choice of $x$. The inclusion of $\lambda$ in the model affects the profitability of S, $P$. In fact, it is assumed to decrease $P$ as in (7.7) by a level $\lambda\left(1+R\right)$ for only the first period. From the latter it is evident that $\lambda \in \left(0,1\right)$. In our two-period extended model $P$ is defined as:

$$P = \left(1-\lambda\right)\left(1+R\right)^2 - \left(1+i_0\right)\left(1+i\right) \tag{7. 48}$$

Equivalently the linear approximation of (7.48) is:

$$P = 2R - i_0 - i - \lambda \, . \qquad (7.49)$$

From (7.10), (7.49) can be expressed as:

$$P = 2R - i_0 - r^* - E\pi - \varepsilon - (\beta - 1)x - \lambda \qquad (7.50)$$

The analysis unfolds in the same manner. We thus directly report the equilibrium outcomes in the extended model.

*(a) The case of monetary policy under discretion ($\Gamma_1$)*

The optimal levels of $E\pi$ and $x$ are derived from the unconstrained optimisation of $U$ as in (7.14), substituting for (7.1) and (7.50), which is of the following form:

$$U = -\left(E\pi + \varepsilon - x - \pi^*\right)^2 - \alpha\left(2R - i_0 - r^* - E\pi - \varepsilon - (\beta - 1)x - \lambda - P^*\right)^2 .$$

For $EP = 2R - i_0 - r^* - E\pi - E\lambda$ and since $EP=Q$ in equilibrium, the above is equal to:

$$U = -\left(E\pi + \varepsilon - x - \pi^*\right)^2 - \alpha\left[\left(Q - P^*\right) + \left(E\lambda - \lambda\right) - (\beta - 1)x - \varepsilon\right]^2 , \qquad (7.51)$$

which we optimise in the similar fashion as in the main model to get the following result:

$$E\pi = \pi^* + \alpha(\beta - 1)\left(P^* - Q\right), \qquad (7.52)$$

and $$x_d = \frac{1-\alpha\left(\beta-1\right)}{1+\alpha\left(\beta-1\right)^2}\varepsilon + \frac{\alpha\left(\beta-1\right)}{1+\alpha\left(\beta-1\right)^2}\left(E\lambda-\lambda\right). \qquad (7.53)$$

The result in (7.53) can be expressed compactly as

$$x_d = \omega_d \varepsilon + \phi_1\left(E\lambda-\lambda\right), \qquad \phi_1 > 0.$$

For $P^* > Q$ and S optimally setting $EP = Q$, for $x_d$ as in (7.53), the optimal response of S is to determine *R* competitively anticipating $x_d$. S determines the optimal level for *R* by equating *EP* with *Q*, where *Q* is affected by the level of *x* chosen by B, and *EP* is affected by the level of *Eπ* determined in equilibrium, as in (7.52).

The level of *Q* is as in (7.11), which takes the following form for *P* as in (7.50) and for *x* as in (7.53):

$$Q = k\left\{\left[\left(\beta-1\right)\omega_d + 1\right]^2 \sigma_\varepsilon^2 + \left[1-\left(\beta-1\right)\phi_1\right]^2 \sigma_\lambda^2\right\}^{\frac{1}{2}}, \qquad (7.54)$$

which can also be expressed substituting for ${}_1$ from (7.53) as:

$$Q = k\left\{\left[\left(\beta-1\right)\omega_d + 1\right]^2 \sigma_\varepsilon^2 + \frac{1}{H^2}\sigma_\lambda^2\right\}^{\frac{1}{2}}.$$

*R* is thus determined in the following way:

$$\left.\begin{aligned} &EP = Q \\ &EP = 2R - i_0 - r^* - E\pi - E\lambda \\ &E\pi = \pi^* + \alpha\left(\beta-1\right)\left(P^* - Q\right) \end{aligned}\right\} \overset{(7.54)}{\Rightarrow}$$

$$R_d = \frac{1}{2}\left\{ i_0 + r^* + \pi^* + E\lambda + \alpha(\beta - 1)P^* + \right.$$

$$\left. + k\left[1-\alpha(\beta-1)\right]\left[\left[(\beta-1)\omega_d+1\right]^2\sigma_\varepsilon^2 + \left[1-(\beta-1)\phi_1\right]^2\sigma_\lambda^2\right]^{\frac{1}{2}}\right\}. \quad (7.55)$$

Comparing the main model under discretion with the same case in the extended model, we realise that even though inflation expectations are formed in the same manner, in the extended model the monetary stance, $x$, is more muted when $\lambda$ is higher than its expected level and more contractionary when $\lambda$ is less than its expected level. In addition, $Q$ is different, in fact higher, in this extended model also driving $EP$ at a higher level.

*(b) The case of commitment to an instrument rule ($\Gamma_2$)*

If B commits to a rule of the same style as in the main model, i.e. as in (7.27) which controls inflation expectations and accommodates shocks to inflation at a certain rate, the results for B are the same as in subsection 7.4.2:

For the rule $U$ as in (7.51), becomes:

$$U = -\left[\omega_0 + (1-\omega)\varepsilon - \pi^*\right]^2 - \alpha\left[\left(Q - P^*\right) + \left(E\lambda - \lambda\right) - \left[(\beta-1)\omega+1\right]\varepsilon\right]^2,$$

And we, therefore, get the result as in (7.34), (7.35), which are the same as in the principal model:

$$\omega_0 = \pi^*,$$

and $$\omega = \frac{\sigma_\varepsilon{}^2 - \alpha\left(\beta-1\right)\left[\left(k^2+1\right)\sigma_\varepsilon{}^2 - k\sigma_\varepsilon P^*\right]}{\left[1+\alpha\left(\beta-1\right)^2\left(k^2+1\right)\right]\sigma_\varepsilon{}^2}.$$

By letting $P^* = k\theta\sigma_\varepsilon$ for $\theta > 0$, we get the result as in (7.38):

$$\omega_r = \frac{1-\alpha\left(\beta-1\right)\left(k^2+1-k^2\theta\right)}{1+\alpha\left(\beta-1\right)^2\left(k^2+1\right)}.$$

In this case S forms $E\pi = \pi^*$ and by anticipating $x = \omega_r\varepsilon$ as above, determines $R$ accordingly in the following way:

$$\left.\begin{aligned} &EP = Q \\ &EP = 2R - i_0 - r^* - E\pi - E\lambda \\ &E\pi = \pi^* \\ &Q = k\left[\left[\left(\beta-1\right)\omega_r + 1\right]^2 \sigma_\varepsilon^2 + \sigma_\lambda^2\right]^{\frac{1}{2}} \end{aligned}\right\} \Rightarrow$$

$$R_r = \frac{1}{2}\left\{i_0 + r^* + \pi^* + E\lambda + k\left[\left[\left(\beta-1\right)\omega_r + 1\right]^2 \sigma_\varepsilon^2 + \sigma_\lambda^2\right]^{\frac{1}{2}}\right\}. \qquad (7.56)$$

For $P^*=Q$, in this case $x=\omega\varepsilon$ for $\omega$ as in (7.20), which is now different from $x$ under discretion. Both under rules and under discretion inflation expectations are anchored to B's target and $x$ under rules is lower to $x$ under discretion by the term $\frac{\alpha\left(\beta-1\right)}{1+\alpha\left(\beta-1\right)^2}\left(E\lambda-\lambda\right)$. Since the rule does not counter the potential levels of default on loans it produces a more muted monetary policy response than under discretion when $\lambda$ is lower than its expected level and more contractionary policy when $\lambda$ is higher than its expected level.

If the rule B announces and commits to aims also to counter the levels of default (a random variable), it can be expressed as:

$$x = \omega_1 + \omega_2 E\pi + \omega_3\left(\lambda - E\lambda\right) + \omega\varepsilon, \qquad \left(\omega_2 > 0\right). \tag{7.57}$$

In a similar manner, taking expectations in (7.57), using (7.4):

$$\begin{aligned} E\pi &= -\frac{\omega_1}{\omega_2} \\ &= \omega_0. \end{aligned} \tag{7.58}$$

Substituting (7.58) in (7.57):

$$x = \omega\varepsilon + \omega_3\left(\lambda - E\lambda\right). \tag{7.59}$$

Substituting (7.58) and (7.59) in (7.51) :

$$\begin{aligned} U = &-\left[\omega_0 + \varepsilon - \omega\varepsilon - \omega_3\left(\lambda - E\lambda\right) - \pi^*\right]^2 - \\ &-\alpha\left\{\left(Q - P^*\right) - \left[\left(\beta - 1\right)\omega + 1\right]\varepsilon - \left[\left(\beta - 1\right)\omega_3 + 1\right]\left(\lambda - E\lambda\right)\right\}^2. \end{aligned} \tag{7.60}$$

For $P^*=Q$, B's expected utility can be expressed as:

$$\begin{aligned} EU = &-\left(\omega_0 - \pi^*\right)^2 - \left(1 - \omega\right)^2 \sigma_\varepsilon^{\,2} - \omega_3^{\,2}\sigma_\lambda^{\,2} - \\ &-\alpha\left[1 + \left(\beta - 1\right)\omega\right]^2 \sigma_\varepsilon^{\,2} - \alpha\left[1 + \left(\beta - 1\right)\omega_3\right]^2 \sigma_\lambda^{\,2}. \end{aligned} \tag{7.61}$$

Differentiating (7.61) with respect to $\omega_0$, $\omega$ and $\omega_3$, and equating to zero:

$$\omega_0 = \pi^*,$$

$$\omega = \frac{1-\alpha(\beta-1)}{1+\alpha(\beta-1)^2},$$

$$\omega_3 = -\frac{\alpha(\beta-1)}{1+\alpha(\beta-1)^2}. \tag{7.62}$$

Comparing (7.62) with (7.53), we conclude that for $P^*=Q$ both types of pre-emptive monetary policy (under rules and under discretion) produce the same level for $x$ in the extended model when the rule counters $\lambda$, the random levels of default on loans issued by the financial sector. The reasoning is the same as in the equivalent case in the main model. Since B defines its financial stability objective in terms of $Q$, the level of S's expected profits that guarantees the sector's survival and since $Q$ is affected by the monetary policy reaction, under common knowledge S incorporates B's anticipated countering of random $\varepsilon$ and $\lambda$ (from the form of the rule) at time $t$=1 when it determines its behaviour at $t$=0. In this case, any perceived risks to financial stability are encountered principally by S, so long as B identifies and announces the presence of an explicit objective for financial stability ($\alpha$>0). Even though, B's reaction to the inflation shock $\varepsilon$ and to levels of default $\lambda$, i.e. $x$, is the same as under discretion, commitment to the rule manages to anchor inflation expectations to B's target making the latter the preferred policy.

The case for $P^*>Q$ is not discussed because of the complexity in the derivation of the result and since no significant contribution is provided. For a rule which is better defined and, thus, counters both 'shocks' as in (7.57) the extended model results in the same type of time-inconsistent policy as in the main model.

Therefore, the main result is similar in both the extended model and the model excluding $\lambda$, which is that the superior monetary policy for B is the commitment to a rule in contrast to discretionary policy-making.

## 7.7 Policy Implications

The analysis solely addresses monetary policy that is known to aim at the pre-emption of the growth of perceived financial imbalances, positive or negative (present in the financial sector), and the main policy implications generated refer both to the design and the conduct of such monetary policy.

Considering the *design* of monetary policy, we show that when the monetary policy-maker takes into account the effects on policy-making of the strategic interaction between itself and the financial sector, and passes forward clear announcements of this concern, the resulting policy is optimal when it follows a rule contrary to the literature on pre-emptive monetary policy which neglects (to our knowledge) the crucial effect of such interaction. A central bank recognising, first, that its primary tasks are to support the value of the currency (of the economy it is based on) and guarantee the efficient operation of the system it supervises (namely the banking system – and overall the financial system), and second, that the effect of its policy is transmitted to the varied parts of the real economy through the financial system, can evaluate that its strategic interaction with the financial sector will determine the context in which the real sector operates (irrespective of the structure of the economy). The shift of focus in the interaction as of above will affect the behaviour of both the central bank and the financial sector, each, in turn, affecting several segments of the real economy.

A further implication of our work referring to the design of pre-emptive monetary policy is the proposition of a financial stability objective in terms of the profitability of the financial sector; the latter modelled with respect to the spread between the rate on long-term financial instruments and rate of the instrument of monetary policy.

Considering the *conduct* of monetary policy, we contend that discretionary monetary policy when B aims to pre-empt perceived financial imbalances in the financial sector is not the optimal style of policy. A further policy implication of our model is that the chosen pre-emptive monetary policy (deviation from the rule on the receipt of new information after the rule is believed) is time inconsistent, which justifies the necessity of the commitment to a rule by the central bank in a similar fashion to the extant literature on time inconsistent monetary policy that initiated with the seminal contribution of Barro and Gordon (1983a). The analysis highlights the well-articulated in the previous decades need of a central bank to build credibility, yet in this context referring to the achievement and maintenance of financial stability, as an explicit monetary policy objective. A definition of credibility given by Blinder (1999) involves "words matching deeds": "A central bank is credible if people believe it will do what it says" (quoted in Svensson (1999), p. 217). When a central bank has announced a policy goal then credibility will boil down to private expectations being consistent with the goal. On a practical policy level, Svensson (1999) states that when a central bank has an explicit inflation target, then credibility can be defined as private inflation expectations coinciding with the inflation target, while lack of credibility can be identified as any deviation of private inflation expectations from the inflation target (be it for inflation expectations above or below the target). Since inflation expectations can be measured or estimated (eg. from surveys or yield curves), the degree of central bank credibility can also be explicitly measured (Svensson (1999), p. 217). The argument can be directly extended for the addition of a target for the financial stability objective.

## 7.8 Concluding Remarks

Following the debate on the inclusion or not of perceived financial imbalances in the conduct of monetary policy before the forecasts to inflation are affected, we evaluate monetary policy that is conducted pre-emptively against financial instability in a simple model analysing the strategic interaction between a central bank and a financial sector.

We model the central bank as having the objectives of price stability and financial stability, where the latter is a function of the profitability of the financial sector against a benchmark. In line with the results proposed in the extant literature in favour of pre-emptive monetary policy (for example as in Borio (2005), Borio and Lowe (2002), Bordo and Jeanne (2002), Cecchetti et al. (2003), White (2006)) that (to our knowledge) calls for more flexibility and the use of longer time-horizons in the conduct of monetary policy we assess monetary policy under discretion and under commitment to an instrument rule.

In contrast to the relevant literature, but similar to the literature that initiated with Barro and Gordon (1983a), yet in the new context proposed, our analysis concludes that when a central bank addresses financial stability as a main and systematic component of its decision making process, namely as an explicit monetary policy objective, then policy yields better results in terms of controlling inflation, anchoring inflation expectations to the central bank's inflation target and enhancing financial sector profitability when conducted under commitment to a rule. As the monetary policy rule in this model is actually one that aims to control inflation expectations, commitment to it accomplishes this aim. Turning to the fact that commitment to the rule enables monetary policy to enhance the financial sector profitability this is so because in this case the monetary policy reaction is higher leading, thus, the financial sector to face a higher level of minimum expected profits. Since the expected profits faced by financial firms are higher, a stimulus is provided to the latter in order to increase their profitability and avoid seizing operation. Therefore, under substantial threat of financial instability the proposed policy induces the financial sector to impose more prudence on its operation.

**Appendix**

In order to compare the design of optimal pre-emptive monetary policy in the context proposed with the standard style of policy that aims at the two objectives of stabilising inflation and the output-gap, we operate the model proposed for the central bank, B, aiming at the above objectives.

A simplified structure of the economy is modelled through four equations, where the first three are identical to the structure of the economy employed in the main model as in (7.1), (7.2), and (7.3) and the fourth is an equation describing the growth in output. The last equation is the following:

$$y_t = g_t + \eta_t - \gamma x_t \quad \text{for} \quad \eta_t \sim \text{iid}\, N\left(0, \sigma_\eta^2\right) \text{ and } \gamma > 0. \tag{A.1}$$

Equation (A.1) defines growth in output as a function of sustainable growth of output, $g$, a shock, $\eta$, and the reaction of the central bank, $x$. Let $y$ denote the growth rate of output at $t$=1. For simplicity we exclude the subscript 1 denoting time $t$=1. In (A.1) $\eta$ is a random shock of mean zero and variance $\sigma_\eta^2$. Since the real sector is still implicit in this model $g$ is determined exogenously. The inclusion of the real sector (the public) as a third player is deemed as inappropriate, because it would complicate the analysis without contributing at this level to the analysis to a great extent. Finally, the level at which B offsets the shock to inflation, namely $x$, affects the growth in output adversely at a rate $\gamma$. We assume that $\varepsilon$ and $\eta$ are jointly independent and are observed during the same period, namely they have both been observed prior to $t$=1, when B applies $x$.

Referring to (7.1), recall that $x$ describes monetary stance and, from (7.3), determines the real short-term rate of interest, $r$. From (7.4):

$$Ey = g\,. \tag{A.2}$$

An alternative interpretation can be that $y$ measures the output gap:

$$y = \frac{Y - Y^*}{Y^*}, \tag{A.3}$$

where $Y$ is output, $Y$=$Y$* is its natural level and $g$=0.

The objective function of B is defined as:

$$U = -\left(\pi - \pi^*\right)^2 - \alpha_1\left(y - y^*\right)^2 \qquad \left(\alpha_1 > 0\right), \qquad \text{(A.4)}$$

Thus, $y$* is the target value for the rate of growth of output or, in the alternative interpretation, the output gap.

B can conduct monetary policy either on a discretionary way after observing the two shocks or by committing to a rule that counters $\varepsilon$ and $\eta$. This rule can be of the following form:

$$x = \omega_1 + \omega_2 E\pi + \omega\varepsilon + \omega_4\eta \qquad \left(\omega_2 > 0\right). \qquad \text{(A.5)}$$

The equilibrium outcomes are determined in the same manner as in Section 7.4.

Define $L = 1 + \alpha_1\gamma^2$. For the case of monetary policy under ***discretion***, differentiating (A.4) with respect to $x$ and equating to zero:

$$x = \frac{E\pi - \pi^*}{L} + \frac{1}{L}\varepsilon + \frac{\alpha_1\gamma}{L}\eta + \frac{\alpha_1\left(g - y^*\right)}{L}. \qquad \text{(A.6)}$$

Taking expectations in (A.6), using (A.2):

$$E\pi = \pi^* - \alpha_1\left(g - y^*\right) \qquad \text{(A.7)}$$

$$x_d = \frac{1}{L}\varepsilon + \frac{\alpha_1\gamma}{L}\eta \tag{A.8}$$

For the case of monetary policy under ***commitment to a rule***, first consider the utility for B from (A.4), using (7.1), and (A.1) which is:

$$U = -\left(E\pi + \varepsilon - x - \pi^*\right)^2 - \alpha_1\left(g + \eta - \gamma x - y^*\right)^2 \tag{A.9}$$

Taking expectations in (A.5) we can express $E\pi$ as:

$$\begin{aligned} E\pi &= -\frac{\omega_1}{\omega_2} \\ &= \omega_0, \end{aligned} \tag{A.10}$$

and from (A.10) and (A.5): $x = \omega\varepsilon + \omega_4\eta$ . (A.11)

Substituting (A.10) in (A.9) and for the rule as in (A.5), (A.9) becomes:

$$\begin{aligned} U = &-\left[\omega_0 + (1-\omega)\varepsilon - \omega_4\eta - \pi^*\right]^2 - \\ &-\alpha_1\left[g - \gamma\omega\varepsilon + (1-\gamma\omega_4)\eta - y^*\right]^2. \end{aligned} \tag{A.12}$$

Taking expectations in (A.12):

$$\begin{aligned} EU = &-\left(\omega_0 - \pi^*\right)^2 - (1-\omega)^2\sigma_\varepsilon{}^2 - \omega_4{}^2\sigma_\eta{}^2 \\ &-\alpha_1\left(g - y^*\right)^2 - \alpha_1\gamma^2\omega^2\sigma_\varepsilon{}^2 - \alpha_1(1-\gamma\omega_4)^2\sigma_\eta{}^2. \end{aligned}$$

Differentiating the above with respect to $\omega_0$, $\omega$, and $\omega_4$ and equating to zero, we get the following results for:

$$\omega_0 = \pi^*, \tag{A.13}$$

$$\omega = \frac{1}{L}, \tag{A.14}$$

$$\omega_4 = \frac{\alpha_1 \gamma}{L}. \tag{A.15}$$

Therefore, under rules $x_r = \frac{1}{L}\varepsilon + \frac{\alpha_1 \gamma}{L}$. Comparing (A.13) with (A.7), we see that, when $y^*=g$, the results under rules are the same as under discretion. As before, when $y^*>g$, i.e. a higher rate of growth for output is preferred to its average rate, rules do better than discretion since, while $x_r = x_d$, they control inflation expectations better; in fact under commitment to a rule inflation expectations are anchored to the central bank's targeted level. Admitting that our results are governed by the definition of $g$ as an exogenous term, they still demonstrate the optimality of commitment to a rule as a form of monetary policy not contradicting the conventional view.

# CHAPTER 8

# THE CASE OF *INCOMPLETE* INFORMATION

## 8.1 Introduction

In this chapter we extend the two-player game presented in Chapter 7 by modelling one player, the financial sector, as being confronted with incomplete information about the preferences of the other, the central bank. The model analysed in this chapter incorporates a central bank that can either aim at the objective of low and stable inflation (solely) or be of the style analysed in Chapter 7, and, thus, have the dual objective of price and financial stability.

The analysis in this chapter aims to evaluate the effect of vagueness about the central bank's preferences with respect to financial stability both in the behaviour of the central bank and the financial sector. In this context it is investigated whether central banks should state clearly their intention to conduct monetary policy pre-emptively against perceived financial imbalances, or in contrast exercise 'strict inflation targeting'. This kind of extension is justified by the fact that central banks have in general been reluctant to publicize any explicit objective function used as a guide for policy, and also because central banks, even though have serious concerns about the stability of the financial system, they fail to adopt and aim at financial stability as an explicit objective.

Furthermore, the strategic interaction in this chapter is repeated infinitely with the aim to evaluate the role of reputation by analysing a repeated game in the lines of Barro and Gordon (1983b). One of the earliest models of monetary policy set as repeated games of incomplete information is Backus and Driffill (1985), which, however, describes the interaction between the monetary authorities and the public over a finite time-horizon. To our knowledge, the extant literature on pre-emptive monetary policy against financial instability as analysed in Chapter 6, does not incorporate the above concerns of a strategic interaction between the central bank and the financial sector, the uncertainty of the financial sector about the central bank preferences, and the role of reputation of the central bank in the conduct of policy and, thus, does not unfold in a similar manner.

However, a vast literature extended various ways the seminal work of Barro and Gordon (1983a, 1983b), to incorporate the effect of uncertainty of one player about an aspect of the other player's behaviour, but in a context analysing the interaction between the monetary authorities and the public. Among others, for example, Backus and Driffill (1985), Barro (1986), Vickers (1986), Cukierman and Meltzer (1986), Tabellini (1988), Andersen (1989), Cukiernan and Liviatan (1991), Ball (1995), Drazen and Mason (1994), Nolan and Schaling (1996), Briault, Haldane and King (1997) build models in which the public is uncertain about the central bank's preference for the conduct of monetary policy, either as the preference between output and inflation stabilisation or its ability to commit. In these types of models the uninformed player (the public) is trying to infer the type the informed player (the central bank) may be from the actions taken by the later. When the central bank chooses its actions takes into consideration the uncertainty faced by the public and it may also conceal its true preference from the public by mimicking the behaviour of a different type of central bank.

These issues are also investigated in the model in this chapter, yet we refrain from using the assumption that the uninformed player (the financial sector) can draw inferences about the central bank's behaviour by viewing the central bank's actions. In other words, we do not allow in this model for any signalling behaviour from the part of the central bank. Finally, we do not make the assumption that the central bank can accept or be presented with the option to sign any binding contracts of any form.

In this model since the financial sector does not know what type of central bank it faces, even a central bank that prefers to pre-empt financial instability may choose in equilibrium, for suitable levels of parameters, to mimic a 'strict inflation targeting' central bank in order to built its reputation as such, and thus, affect inflation expectations in the future, and have an impact on the stability of the financial sector.

The organization of the chapter is as follows: the next section 8.2 presents the method used in the analysis and the assumptions made. Section 8.3 describes the model and section 8.4 the outcomes that arise in equilibrium which are followed by a discussion in section 8.5. Section 8.6 states the main policy implications of the analysis and section 8.7 is the conclusion.

### 8.2 Preliminaries (method and assumptions)

We assume that a non-cooperative game is played between a central bank, B, and a financial sector, S. This implies that players are not able to make binding agreements (or any sort of other commitments), except for the ones which are explicitly allowed by the rules of the game (van Damme (1983), p. iii).

S chooses a level for the long-term nominal interest rate, *R*. In a simplified view of reality the long-term nominal interest rate is perceived as the price of a main product offered by the financial sector (namely loans issued to the real sector). The financial sector is modelled in the aggregate, as ‘one agent’ that represents the consolidation of the financial intermediaries (i.e. financial firms and institutional investors) which operate in purely competitive markets. Such a seemingly strong assumption is deemed necessary for modelling purposes. Nevertheless, it seems to be justified by the fact that strong competition between financial-market participants makes the ‘leaders’ in the markets (for example financial firms with considerably high levels of capitalisation) not apt to maintain their identity as price-makers (with respect to the pricing of financial assets) over a long horizon. The increasingly rapid dissemination of information in addition to the speed characterising financial transactions makes it considerably difficult for financial firms to maintain competitive advantages (which are known to give the ability to a firm to act as a price-maker) at least without an incessant effort of differentiation in the product offered. A second reason is that financial markets have proven to act almost in unison at times of turbulence. Therefore, a crisis’ intensely rapid contamination of financial-market participants can give credence to our view of the financial sector as acting under pure competition. For the above reasons we also abstract from modelling S with respect to the behaviour of a representative agent instead.

S increases welfare when its survival is guaranteed and profits are increased. As explained in detail in the following sections, profits are perceived in terms of the margin between the rates charged on illiquid and relatively liquid financial assets (the former represented by loans to the real sector and the latter by interbank-market funds). S's 'survival' implies a level of profits low enough to cover the costs of firms' entering and operating in the sector. In accordance to the theory of pure competition, at this lowest level of profits the number of firms entering the market and those ceasing operation (referring in this model to bankruptcy rather than insolvency) are up to a minimum acceptable number.

B controls inflation by choosing the degree of accommodation of the shocks to inflation, which is termed as $x$. Therefore, the choice variable of B is $x$. The central bank, B, is assumed to be independent and solely responsible for monetary policy. The instrument it uses is assumed to be a short-term nominal interest rate, interpreted as the overnight interbank-offered rate, which can be described in terms of $x$. In the interbank-funds market the central bank is essentially a price-maker, and while financial firms resort to this market in order to satisfy their demand for liquidity, the central bank's policy choice influences the behaviour of the financial sector.

The model refers to a closed economy (therefore, exchange rates are not considered as asset prices) with an implicit real sector (thus, only financial assets are under consideration). Since the behaviour of the real sector is not modelled, consumption and investment decisions made by firms and households are reflected in the workings of the financial sector that allocates funds from savings to investment projects. The model, further, presents no role for a government. The latter assumption implies the absence of fiscal policy considerations and, also, that government securities[192] are traded through financial intermediaries in secondary markets, which are, thus, encompassed in the sum of the financial securities.

Time is discreet and *t* denotes a point in time. The information that each player faces is incomplete, in that certain aspects in the description of the game are not known to both players. As described in detail in the following sections, these aspects refer to the preferences of the central bank, player B, which determine its behaviour and, in turn, the behaviour of the other player, S. The game is sequential, in that the strategic interaction between the two players takes place in a sequence of moves, one by each player. The uninformed player, S, makes the first move; then, B moves second and ends the game. Play in a sequence of moves arises from the presence of a second-player advantage, which the second player, B, would otherwise give-up if the strategic interaction between the two players were simultaneous. This advantage stems from the control B has over inflation, using monetary policy to counter inflation shocks, and from the fact that S's profits are bound in long-term contracts that cannot rapidly change in response to new information.

In contrast to the analysis in Chapter 7, we assume that B always conducts policy optimally in the receipt of new information after the realisations of shocks (acts with discretion) and, thus, will not choose to commit to a rule of any form. Allowing B the choice of commitment to a level of *x* by following a rule would have been innocuous, yet it would render the argument in the current model ineffective, as it would reveal B's preferences to S prior to S's making its move. The reason for analysing the case

[192] For arguments for and against the purchase of government bonds, see respectively Oda and Okina (2001) and the comment by Beebe (2001), especially p. 366.

of S's facing incomplete information about the way B makes a strategy-choice lies mainly in the fact that central banks are in effect characterised by a certain vagueness as to an actual objective function they may obey to. In addition, financial stability has not been accounted for as an explicit objective (other than a well-articulated concern) by the mandates of central banks to date. However, as the analysis in Chapter 6 demonstrates, the proposed ways for policymakers to conduct monetary policy so as to address incidents (ex ante or ex post) of financial instability (or even the maintenance of its 'positive' counterpart) involve discretionary judgement when circumstances necessitate it. It is, therefore, contended that it is worth analysing how the reaction of the financial sector to such uncertainty about central bank behaviour affects the way a central bank would conduct its policy under discretion.

Finally, it is assumed that the game can be repeated infinitely. A repeated game is designed in order to "examine the logic of long-term interaction. It captures the idea that a player will take into account the effect of his current behaviour on the other player's future behaviour, and aims to explain phenomena like cooperation and threats" (Osborne and Rubinstein (1994), p. 133). Since the effective conduct of monetary policy and the efficient operation of the financial system are crucial components of a healthy economy, it is important to build a model that addresses these issues over a longer horizon than a one-off interaction. In addition, as Eichberger (1993) points out "repeating a game substantially increases the set of possible strategies because actions, that is, strategies of the stage game, can be made conditional on the observed behaviour of other players in previous stages of the game. This makes possible strategies that enforce a particular behaviour in the stage game by threatening to choose some other action if the opponents do not follow the prescribed behaviour" (Eichberger (1993), p. 213). Infinite as opposed to finite repetition of the game is viewed as more appropriate, because in essence the strategic interaction aims at defining optimal monetary policy (in the context analysed and which is state-contingent), which, once applied, should give no reason to be abandoned from policy-makers, ceteris paribus.

## 8.3 The Model

### *8.3.1 The economy*

The structure of the economy is the same as in Chapter 7. In particular, a simplified structure of the economy is modelled through the following three equations:

$$\pi_t = E\pi_t + \varepsilon_t - x_t \quad \text{for} \quad \varepsilon_t \sim \text{iid}\left(0, \sigma_\varepsilon^2\right) \tag{8.1}$$

$$x_t = \frac{r_t - r^*}{\beta}, \qquad \beta > 1 \tag{8.2}$$

$$i_t = r_t + \pi_t \,. \tag{8.3}$$

Briefly, (8.1) describes inflation. Inflation, $\pi$, is a linear function of, first, the financial sector's inflation expectations, $E\pi$, formed at $t = 0$ with respect to all the available information and, second, an inflationary shock, $\varepsilon$, that is observed at $t = 1$, can be positive or negative with a zero mean, a constant variance $\sigma_\varepsilon^2$ and support $\left(-\infty, \infty\right)$. The third term is the level of accommodation of the shock, $x$, that is achieved through monetary policy, which is applied after the observation of $\varepsilon$, at $t$=1.

In the absence of a shock (i.e. the absence of new information) and for a monetary stance that is 'neutral', the array of prices are raised in line with inflation expectations. The random shock $\varepsilon$ disturbs this behaviour and is countered by $x$.

By taking expectations in equation (8.1) we obtain

$$Ex = 0, \tag{8.4}$$

where $E$ is the expectations operator. This result shows that on average monetary policy is just neutral.

(8.2) captures the transmission of the effect of monetary policy to the real short-term interest rate, $r$, where $r^*$ can be thought of as the 'natural' real rate of interest[193] and $\beta$ as an inverse measure of how effectively the real short-term rate of interest, $r$, controls inflation. To specify how the short-term rate of interest, i, determines monetary stance, assume:

$$x = F(r) \qquad (0 < F' < 1), \tag{8.5}$$

where $r$ is the real short-term rate of interest at $t$=1, as in (8.3). The restriction on $F'$ means first, $r$ and $\pi$ are inversely related and second, in order to raise $r$ and lower $\pi$, it is necessary to raise $i$. It is supposed that the transmission mechanism from $i$ to $\pi$ is via $r$ and its effect on the real economy. Substituting (8.3) in (8.5) and (8.5) in (8.1) shows that, given $F$, $E\pi$ and $\varepsilon$, the choice of $i$ determines $\pi$, $r$ and $x$. Therefore, in determining strategy, B could as equally set a target for $r$, or for $x$, as choose the

[193] Woodford (2003), (pp. 21, 49-55) provides an analysis on Wicksell's notion of the natural real rate of interest, i.e. the rate of interest required for equilibrium with stable prices. It is also referred in the literature as the neutral or the equilibrium real rate of interest.

level of its instrument, *i*. From (8.4), the central bank's monetary stance is on average neutral. Let $F\left(r^*\right)=0$. If $r>r^*$, monetary policy is restrictive and, if $r<r^*$, it is expansionary. Then for simplicity we assume that *x* is as in (8.2).

(8.3) describes what is known as the Fisher identity (termed after Fisher (1896)), the (approximately) one-for-one adjustment of nominal interest rate, *i*, to the level of inflation (in a steady state). We use this equation in a way that describes actual inflation and the ex post real interest rates. The detailed account of these three equations remains as in Chapter 7. For simplicity in notation subscript 1 for time $t$=1 is excluded throughout the chapter.

### *8.3.2 The game-structure*

In this game one of the two players, S, is assumed to face incomplete information about the preferences of the other player, B. In particular, B can obey to a utility function that is unknown to S, and which can be of two particular forms, discussed in the next subsection. Therefore, S has incomplete information about the pay-offs B receives for each strategy-combination and, thus, S cannot predict B's behaviour, which in turn affects S's own behaviour. The information S has with respect to this issue is the exact form of each utility function B may be facing, as well as the probability assigned to B's facing each utility function. It is assumed that S has full information about the strategy-sets that both players are facing[194].

[194] It is contended as more appropriate to define the lack of information faced by S in terms of incomplete information about pay-offs since one can transform a game with incomplete information about strategy sets into a game with incomplete information about pay-offs by expanding the strategy spaces of the players accordingly, as in Harsanyi (1967).

In order to evaluate the behaviour of each player, we use the method proposed by Harsanyi (1967) so as to transform a game of incomplete information to a game of imperfect information[195], which is a type of strategic interaction for which the players' best responses and equilibrium behaviour are well defined. In this case, S that faces incomplete information about B's pay-offs is treated as if he were uncertain about the type of B he will face during the interaction. In our model, B can be of two types, one for each form of utility function, while S can be of one type, so we address S's case with certainty. An artificial player is introduced, called 'nature' that moves first in the game and chooses according to some probability distribution the type of B that will play the game. Information is imperfect because the player that moves right after nature, namely S, cannot observe the move of nature. Therefore, the incompleteness of information about pay-offs is transformed into uncertainty about the move of nature. As noted in Eichberger (1993) nature can play a unique mixed strategy which is the probability distribution over types and, thus, a pay-off function need not be introduced for nature (Eichberger (1993), p. 126).

A way to describe a game can be a summary of the rules of the game by indicating "the choices available to each player, the information a player has when it is his turn to move, and the pay-offs each player receives at the end of the game" (van Damme (1983), p. 3). In this section we introduce these aspects that are necessary to define the game. The next subsection describes in detail the pay-off functions for each player. A pay-off function is the function that determines each player's pay-off from

[195] Imperfect information implies that when each player has to make a move they do not know exactly what happened in previous moves.

the combination of actions chosen by the players (Gibbons (1992), p.1) [196]. Then a subsection follows presenting the sequence of events in our analysis. The word 'event' is used rather arbitrarily, as it does not represent the notion of 'a subset of the set of states of nature' that the term 'event' usually denotes in decision theory (see eg. Mas-Colell et al. (1995), Chapter 6). By describing a 'sequence of events' we rather portray every occurrence that may take place in the context of the analysis at any time (in this fashion following Walsh (2000), p. 328). In this way, we present the information each player has when it is his turn to make a move. Finally, a compact description of the game is given in the last subsection.

### *(ii) Objective functions*

The objective function of player S is the one described in Chapter 7. $R$ is competitively determined. The welfare of S (the consolidated, competitive, financial sector) increases with profits. Through competition expected profits of S are driven down to a minimum level that makes the risk of non-survival just acceptable, which is termed as $Q$. The profitability of S, $P$, is modelled in terms of a loan issued (to the real sector) over a two-period horizon. Let $i_0$ be the short-term rate of interest at $t$=0, and recall that $i$ is the short-term rate of interest at $t$=1. Assume $i_0$ (but not $i$) is known to S when S chooses the long-term rate of interest, $R$, at $t$=0. At $t$=2, S obtains profits per unit of currency:

[196] The term 'pay-off function' is common in game theory while in economics the term 'objective function' is more commonly used. An 'objective function' is associated with an optimisation problem and it determines how good a solution can be to the pertinent agent or agents. Since each player in the game faces an optimisation problem with respect to the other player's optimisation problem, both terms can be used.

$$P = (1+R)^2 - (1+i_0)(1+i). \tag{8.6}$$

However, for simplicity, and because nothing essential is involved, the following linear approximation is used:

$$P = 2R - i_0 - i. \tag{8.7}$$

Substituting (8.1), (8.2) and (8.3) in (8.7):

$$P = 2R - i_0 - r^* - E\pi - (\beta - 1)x - \varepsilon. \tag{8.8}$$

Taking expectations in (8.8) using (8.4), expected profits can be described as:

$$EP = 2R - i_0 - r^* - E\pi. \tag{8.9}$$

Through competition *EP* is set equal to *Q* mentioned above. *Q* is defined as a function of the standard deviation of profits *P*, which, as is evident from (8.8), is affected by the variation of *x* and *ε*. In particular:

$$Q = k\sigma_P \qquad (k > 0). \tag{8.10}$$

Coefficient *k* in (8.10) describes any structural features of the financial sector affecting its competitive level of profits, like administrative costs, psychological factors, or the presence of economies of scale. Since by construction *Q* is positive, as well as $\sigma_P$, *k* is also assumed to be positive. Letting 'var' denote variance, we note, from (8.4) and (8.8), that:

$$\text{var}(P) = \text{var}\left[(\beta - 1)x + \varepsilon\right]. \tag{8.11}$$

We assume competition drives the expected value of $P$ to $Q$ as in (7.10), so the assumption is for:

$$\begin{aligned} EP &= Q \\ &= k\sigma_P \qquad (k > 0). \end{aligned} \tag{8.12}$$

Therefore, (8.12) determines the optimal level of $R$ under competition, as a function of $i_0$, $r$*, $E\pi$, $x$, and $\varepsilon$.

Turning to the objective function of B, we model B as choosing $x$ by optimising using the following utility function:

$$U = \begin{cases} U_1 = -(\pi - \pi^*)^2, & \text{with prob. } p, \\ U_2 = -(\pi - \pi^*)^2 - \alpha\ (P - P^*)^2, & \text{with prob. } 1 - p. \end{cases}$$

$$\text{for } \alpha > 0, \quad p \in [0,1], \tag{8.13}$$

where $\pi$* and $P$* are the central bank targets for the rate of inflation and financial sector profitability respectively.

In the above, $U_1$ is the objective function of a 'strict inflation-targeting' central bank (as eg. in Svensson (1999c)) caring only for price stability, while $U_2$ describes a central bank having the objectives of price stability and financial stability (as in the model analysed in Chapter 7), conducting, thus, pre-emptive monetary policy against perceived financial imbalances (as described in Chapter 6). Strict inflation-targeting is used as a borderline case[197]. The probability *p* of B facing a utility function as in $U_1$ is known to both players[198]. In particular, in this game, as in Backus and Driffill (1985) "the probability *p*, is a sufficient statistic for past play and contains all the relevant information needed by the players to make optimal decisions" (Backus and Driffill (1985), p. 533).

As a caveat, similar to the analysis in Chapter 7, we refer to Eichberger's (1993) remark that the common practice in economics is to take the curvature of an expected utility function to represent the corresponding agent's attitude towards risk, while "in game theory it is usually assumed that *payoffs represent the subjective evaluation of the outcome of a play by the agent* (emphasis not in the original text). This means that the payoffs are assumed to reflect a player's risk attitudes. Consequently, attitudes to risk are rarely explicitly considered in game-theoretic analysis" (Eichberger (1993), p. 22). Hence, we refrain from making such considerations in the current analysis.

### *(iii) The sequence of events*

The strategic interaction between S and B takes place between points in time $t = 0$ and $t = 1$. Before the interaction takes place, at $t = -1$, B sets a target for inflation, $\pi^*$,

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[197] See Svensson (1999b) for a discussion of this case as a form of a monetary policy rule.

[198] The important issue is the assumption that all players agree on a certain prior distribution on the initial states (from which nature will make a choice). This is implicitly defined by assigning a single probability, here *p* for $U_1$ and (1-*p*) for $U_2$. Kreps (1990) remarks that there is no reason to make this assumption in theory and that we could assume that different players have different priors over nature's initial move, although we would still assume that each player is aware of the priors assessed by the other (Kreps (1990), p. 467). We though contend that jettisoning the assumption would complicate the analysis while making a marginal contribution.

with the aim to anchor S's expectations of inflation around the target, and a target for the level of profitability of S, $P^*$. $P^*$ reflects the level of $P$ that the central bank views as sufficient to guarantee S's survival and proper functioning, in terms of channelling funds from savings to investments. The level of the short-term nominal interest rate that resulted from past policy, i.e. $i_0$, and the level of the 'neutral' real interest rate $r^*$, are predetermined and known to both players at $t$ = -1, as well as the distribution of the shock $\varepsilon$. The level of $Q$, at which S finds the chances of bankruptcy of some firms in the sector just acceptable, is known to both players at $t$ = -1, before the start of the game. In particular, as $Q$ is a function of the monetary policy reaction $x$, it is its functional form that is known before the interaction takes place. Both players know before the interaction that B can be of two certain types that are also known. Therefore, before the game starts B and S know that B can face either $U_1$ or $U_2$ as in (8.13) for a positive level for $\alpha$, the weight assigned on the financial stability objective, in $U_2$, denoting the preferences of the central bank for the stability of the financial sector and a level for $p$, the probability that B faces $U_1$, between the values zero and one, inclusive. The joint probability distribution over the players' types, $\mu$, is also given at $t$ = -1.

Just before the interaction starts, the artificial player 'nature' makes a move and determines which types of players will actually play the game. Nature chooses a type for B from the set of types, which includes the two alternatives of B exercising strict inflation targeting or B conducting pre-emptive monetary policy. Formally, the set of types of B has two elements and the set of types of S has one element (denoting certainty about S). After nature makes a move each player receives information only about their own type and not that of the other player (imperfect information).

After nature reveals the corresponding type to each player, i.e. ($\tau$) to S and any of ($U_1$, $U_2$) to B with respect to the joint probability distribution $\mu$, each player updates their beliefs about the opponent's type after learning the type assigned to them. The updating method is of a standard Bayesian style and the resulting conditional probability distribution over type-combinations is $\mu'$. In our simple model, though, since there is no uncertainty about the type of S, $\mu'$ corresponds to the joint probability distribution $\mu$, and the updating of beliefs is rather trivial. In particular, using Bayes' rule the conditional probability distribution on $T_S$ (the set of types for S) is:

$$\mu'_S\left(U_1|\tau\right) \equiv \frac{\mu\left(\tau, U_1\right)}{\mu\left(\tau, U_1\right)+\mu\left(\tau, U_2\right)} = p,$$

$$\text{and} \quad \mu'_S\left(U_2|\tau\right) \equiv \frac{\mu\left(\tau, U_2\right)}{\mu\left(\tau, U_1\right)+\mu\left(\tau, U_2\right)} = 1 - p. \qquad (8.14)$$

It is evident, therefore, that S learns nothing about B's type by observing its own type. In addition, since the type of S, $\tau$, is common knowledge, there is nothing to be learned for B of any type either. In fact, the conditional probability distribution on $T_B$ (the set of types of B) is:

$$\mu'_B\left(\tau|U_1\right) \equiv \frac{\mu\left(\tau, U_1\right)}{\mu\left(\tau, U_1\right)} = 1, \quad \text{and} \quad \mu''_B\left(\tau|U_2\right) \equiv \frac{\mu\left(\tau, U_2\right)}{\mu\left(\tau, U_2\right)} = 1.$$

Since B can be of either of the two types in $T_B$, and once nature has made a move, B is confronted with two alternative choices when it is its turn to move. These are either to behave according to its type or mimic the equilibrium behaviour of the other type. In this model such a choice is governed by rational behaviour. If in equilibrium B of any type chooses the optimal action according to its type then the equilibrium is defined as ‘separating’. Conversely, if B of at least one type mimics the equilibrium behaviour of the other type of B, then the equilibrium is termed as ‘pooling’.

After the move of nature, S makes a move at $t$=0. Apart from the uncertainty about the move of nature (dealt by the distribution $\mu$), S also forms beliefs about B’s ‘separating’ or ‘pooling’ when it moves at $t$=1. These beliefs are described by a subjective probability $q$ for a rise of a ‘separating’ equilibrium, and (1-$q$) for ‘pooling’. As a reminder, every aspect in the game other than the actual choice of nature is common knowledge.

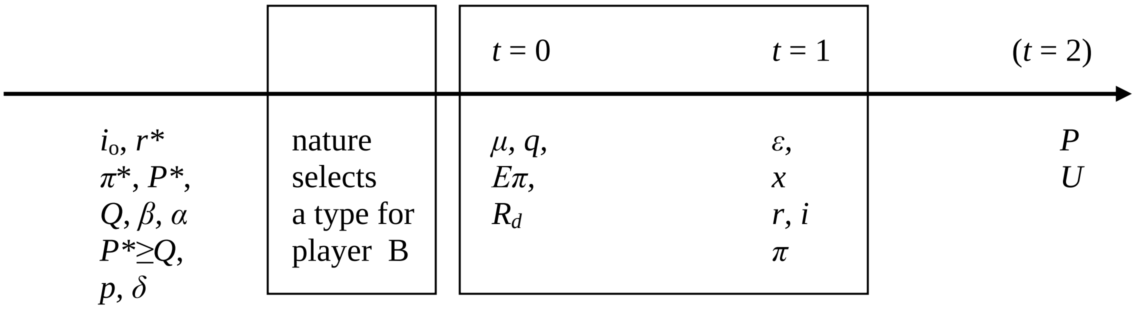
Since after the shock to inflation, $\varepsilon$, is realised (sometime between points in time $t$ = 0 and $t$ = 1) B defines $x$ at $t$=1 on a discretionary basis (i.e. by maximising its objective function in actual rather than expected terms), $E\pi$ are determined with respect to equilibrium behaviour.

At $t$ = 0, S determines $R$ competitively by setting its expected profits $EP$ to equal $Q$. Therefore, $R$ is a function of $E\pi$ and $x$. Under complete information, S is informed about B’s behaviour when determining a level for $R$. Then, at $t$=1, B chooses $x$ after observing $\varepsilon$ and $R$. Defining $x$ is equivalent to defining $r$ or $i$. Furthermore, at $t$ = 1 the actual level for $\pi$ is realized.

Two cases for B’s target for financial stability are further distinguished, namely for $P^*=Q$ and for $P^* > Q$. Since central banks care for the safety and smooth functioning of the financial sector they tend to be either more prudent than the financial system participants (the case for *P* >Q*) or willing to let the markets function at their own pace (the case for *P*=Q*) . Therefore, we do not consider the case of B choosing *P*<Q*.

Figure 8.1 below gives a graphic representation of the sequence of events in our model.

***Figure 8.1: Sequence of events***




A point in time $t$=2 is used for modelling purposes, as it is necessary for the definition of a long-rate that is earned after two periods.

At $t$=1 the whole interaction described above is repeated, over $t$=1 and $t$=2. At $t$=2 the same style of interaction is taking place. This process is repeated to infinity. A discount factor, $\delta$, is attached to the 'per-interaction' values in this process and is known to both players before the start of the game. Every single interaction is conventionally termed as a 'stage-game'. This chapter considers, without loss of generality and avoiding unnecessarily complicated notation, an infinitely repeated game with identical discount factors $\delta \in (0,1)$ for all players. We exclude that such a discount factor covers the extreme cases when players care only for the present ($\delta$=0) and when there is no discounting of the future ($\delta$=1). Exclusion of the latter is important for the existence of equilibrium, while of the former is vital for the important assumption that at least one player, namely the central bank, cares about its reputation. This latter consideration necessitates that this player cares about the future to some extent.

### *(iv) Game description*

A compact description of the game is the following:

[1] Nature selects a type for player B from the set of types.

[2] S forms its beliefs $\mu$ about B's type and $q$ about B's equilibrium behaviour.

[3] $E\pi$ are formed rationally.

[4] S chooses $R$ with respect to $E\pi$, $\mu$, and $q$.

[5] B chooses $x$ with respect to $R$ and $E\pi$ after observing $\varepsilon$.

## 8.4 Equilibrium Outcomes

The behaviour of each player in this game is described by the definition of the pertinent equilibrium. Because of the incomplete information the game does not have properly defined subgames and therefore subgame perfection cannot be used to reach a solution (as in the games in Chapter 7 which incorporated complete and perfect information). Because the moves in every per-period game are made sequentially, the concept of equilibrium used is the perfect Bayesian equilibrium. In a perfect Bayesian equilibrium (i) players maximise their own objective functions independently choosing a strategy given their assessment of the opponent's behaviour at each information set[199] given the beliefs at each information set and (ii) beliefs are consistent with equilibrium strategies (Eichberger (1993), p. 167). In this model the second requirement for equilibrium is justified by the fact that, first, a belief at an information set is simply a probability distribution over the possible moves in this information set (while at information sets where one move is possible the probability assigned is one). Given such beliefs it is possible to evaluate the optimality of the strategy combinations at every information set. What is optimal at an information set, however, depends on the particular beliefs held by the player. To avoid complete arbitrariness of these beliefs, certain consistency requirements have to be satisfied. In particular, as stated above, beliefs must be consistent with the strategies played in equilibrium[200] (Eichberger (1993), p. 166). Finally, for infinite-horizon games the sum of per-period game pay-offs is defined as the limit of the sequence of payoffs in the repetitions of the game as the time-horizon diverges to infinity[201].

---

[199] The notion of an information set implies that certain subsets of decision nodes (in a game-tree – the graphing representation of a sequential-move game as the current model) are such that the player choosing the action at one of the nodes does not know which of those nodes he is at (Kreps (1990), p. 367).

[200] Nevertheless, this requirement does not impose a restriction on out-of-equilibrium beliefs, namely beliefs about play at information sets with zero probability. Different notions of equilibria accounting for equivalent restrictions have been proposed (see eg. the definition of 'sequential equilibrium' by Kreps and Wilson (1982) among others). It is contended, however, that advancing the definition of equilibrium would necessitate a considerable amount of technicality, that does not contribute to a great extent to the main conclusions of the analysis. To this point it is worth mentioning, though, that imposing further such restrictions would reduce the multiplicity of equilibria that arise in the model.

[201]This limit is well defined. Pay-offs of the stage-game are bounded (from the definitions of the objective functions), and thus the sequence of average pay-offs will converge as the time-horizon goes to infinity provided that the discounting factor is strictly less than one, $\delta<1$ (see Eichberger (1993), p. 211, for more general comments on this point).

The equilibrium outcomes are presented in terms of pure strategies[202] – so as to convey the insights of the analysis more promptly avoiding complex notation that may not contribute much to the analysis. Before presenting the equilibrium outcomes in each stage-game, it is important to note that inflation expectations $E\pi$ that are formed at $t$=0, are defined in equilibrium, and B's choice of $x$ at $t$=1 affects $\sigma_P$ which determines $Q$. In addition, $\sigma_P$ is a function of $p$, $q$, $\alpha$, $\beta$ and $\sigma_\varepsilon$. S chooses $R$ at $t$=0 by setting $EP=Q$. $EP$ is affected by $E\pi$. Therefore $R$ is determined by $E\pi$, the beliefs of S for the choice of nature ($\mu$, i.e. $p$, 1-$p$) and the choice of B of type 2 to pool or separate (from type 1's optimal strategy) ($q$, 1-$q$).

Finally, let $\pi = \pi_1$ for B of type 1 and $\pi = \pi_2$ for B of type 2. In addition, for $x$ measuring B's monetary stance, then $x = x_1$ for type 1 and $x = x_2$ for type 2. Assume:

$$\pi_1 = E\pi + \varepsilon - x_1, \qquad (8.1a)$$ [203]

$$\pi_2 = E\pi + \varepsilon - x_2. \qquad (8.1b)$$

According to the move of nature, B is of type 1 or type 2, with probabilities $p$ and 1-$p$, respectively. From (8.14) describing the beliefs of S about B's type, $\mu'$, these coincide with the above. Since $E\varepsilon$=0, it follows from (8.1), (8.1a) and (8.1b) that:

[202] Perfect Bayesian Equilibria are defined in terms of 'behaviour strategies'. In the latter agents are allowed random choices at each information set at which they have to make a move. In contrast to a pure strategy combination, a behaviour strategy combination will not determine a unique path of play in the game, but rather will induce a probability distribution on agents' payoffs (these payoffs being determined by pure strategy combinations). Therefore the expected payoff of a player from a behaviour strategy combination is the expected value of payoffs given the probability distribution on the terminal nodes (when the game ends) induced by the relevant behaviour strategy combination (Eichberger (1993), p.23).

[203] To avoid confusion the same number is used as in equation (8.1), since, in essence (8.1a) and (8.1b) represent the same structure as in (8.1). The same reasoning also lies behind the numbering of (8.4a).

$$pEx_1 + (1-p)Ex_2 = 0. \qquad (8.4a)$$

<u>Choice of *x* at *t*=1</u>

It is convenient and inessential as shown above, to regard B as choosing $x$ rather than $i$, on observing $E\pi$, $\varepsilon$, $i_0$, $r^*$, $\beta$ and $R$. Substituting from (8.1), (8.2), (8.3) and (8.8) into (8.13):

$$U_1 = -\left(E\pi + \varepsilon - x_1 - \pi^*\right)^2 \qquad (8.15a)$$

$$\begin{aligned} U_2 = &-\left(E\pi + \varepsilon - x_2 - \pi^*\right)^2 - \\ &-\alpha\left\{2R - i_0 - r^* - E\pi - \left[(\beta-1)x_2 + \varepsilon\right] - P^*\right\}^2. \end{aligned} \qquad (8.15b)$$

*B of Type 1*

When B is of type 1 by differentiating (8.15a) with respect to $x_1$ and equating to zero, the following holds:

$$x_1^* = E\pi + \varepsilon - \pi^* \qquad (8.16)$$

$$U_1^* = 0. \qquad (8.17)$$

From (8.17) it is evident that in this case B can receive the highest level of utility (i.e. zero) since its objective function is a negative quadratic function. From (8.16), we see that in this case (for B being of type 1 with certainty) B has perfect control over inflation expectations as $E\pi = \pi^*$, and completely offsets the shock to inflation, as for $x$ as in (8.16), $x_1^* = \varepsilon$ for $E\pi = \pi^*$. Therefore, when B is of type 1, it will always choose to reveal its type in equilibrium, which implies that it will always choose $x$ as in (8.16). In this case, however, at $t$=1 actual inflation will reach its targeted level, if not only B, but also S knows that B is of type 1. Yet, this is not the case, and, thus, the inflation expectations are not equal to $E\pi = \pi^*$. $E\pi$ is determined in equilibrium with respect to the alternative equilibria that may arise and the beliefs S holds for each one arising. This is presented after the investigation of the optimal level of $x$ chosen by B at $t$=1 in each case. The level that actual inflation takes, respectively, is given below after we present the choice of $x$ when B is of type 2.

*B of Type 2*

When B is of type 2 it is confronted with the alternative to act according to its type, i.e. choose the relevant level of $x$ defined optimally (separating equilibrium), or conceal its true identity and act as if it were of type 1 and, thus, choose $x$ as in (8.16) (pooling equilibrium). In the latter, S will remain uncertain about the true identity of B. B may choose to pool in order to induce S to expect low inflation in the future.

*Pooling:* In this case $x_1^* = x_2^*$, and so:

$$U_2^* = -\alpha\left\{2R - i_0 - r^* - E\pi - \left[\left(\beta - 1\right)x_1^* + \varepsilon\right] - P^*\right\}^2$$

$$= -\alpha\left\{P^* - Q - \left[\left(\beta - 1\right)x_1^* + \varepsilon\right]\right\}^2 \overset{(8.16)}{\Rightarrow}$$

$$\begin{aligned} U_2^* &= -\alpha\left\{P^* - Q - \left[\left(\beta - 1\right)\left(E\pi + \varepsilon - \pi^*\right) + \varepsilon\right]\right\}^2 \\ &= -\alpha\left\{P^* - Q - \left[\left(\beta - 1\right)\left(E\pi - \pi^*\right) + \beta\varepsilon\right]\right\}^2. \end{aligned} \quad (8.18)$$

The level of utility in (8.18) represents the disutility faced by B of type 2 for choosing only to meet the target for inflation, while it also shares concerns about financial stability (defined as an explicit objective).

*Separation:* Optimal $x$ for B of type 2 in a separating equilibrium is derived as in Chapter 7. Differentiating (8.15b) with respect to $x_2$ and equating to zero:

$$E\pi + \varepsilon - x_2 - \pi^* + \alpha(\beta - 1)\left\{2R - i_0 - r^* - E\pi - \left[(\beta - 1)x_2 + \varepsilon\right] - P^*\right\} = 0$$

$$\begin{aligned}&\left[1 + \alpha(\beta - 1)^2\right]x_2 = \\ &= E\pi + \varepsilon - \pi^* + \alpha(\beta - 1)\left(2R - i_0 - r^* - E\pi - \varepsilon - P^*\right).\end{aligned} \tag{8.19}$$

Let $H = 1 + \alpha(\beta - 1)^2$.

Then, from (8.19) and for $H$ as above:

$$x_2^{**} = \frac{E\pi - \pi^*}{H} + \frac{\left[1 - \alpha(\beta - 1)\right]\varepsilon}{H} - \frac{\alpha(\beta - 1)\left(P^* - Q\right)}{H}, \tag{8.20}$$

$$\begin{aligned}U_2^{**} &= -\left(E\pi + \varepsilon - x_2^{**} - \pi^*\right)^2 - \\ &\quad - \alpha\left[P^* - Q + (\beta - 1)x_2^{**} + \varepsilon\right]^2,\end{aligned} \tag{8.21}$$

where $x_2^{**}$ is given by (8.20).

<u>$E\pi$ at $t$=0</u>

Assume at $t$=1 type 2 chooses 'pooling' with probability $q$ and 'separation' with probability 1-$q$, and, as stated above, B is believed to be of type 1 with probability $p$ and of type 2 with probability (1-$p$). From (8.4a), (8.16) and (8.20):

$$\begin{aligned} 0 &= pEx_1 + (1-p)Ex_2 \\ &= pEx_1^* + (1-p)\left[qEx_1^* + (1-q)Ex_2^{**}\right] \\ &= \left[p + (1-p)q\right]\left(E\pi - \pi^*\right) + \\ &\quad + (1-p)(1-q)\left[E\pi - \pi^* - \alpha(\beta-1)\left(P^* - Q\right)\right]. \end{aligned}$$

Therefore,

$$E\pi - \pi^* = (1-p)(1-q)\alpha(\beta-1)\left(P^* - Q\right), \tag{8.22}$$

where $\quad (1-p)(1-q)\alpha(\beta-1)\left(P^* - Q\right) \geq 0.$

From (8.22) we observe that for higher levels of $q$, S's beliefs that B of type 2 will choose 'pooling' at $t$=1, $E\pi$ would be lower, hence B of type 2 exercises better control over inflation expectations when it chooses 'pooling'. It is also worth noting that (8.22) results from the equilibrium relationship (8.4) and equivalently (8.4a). Because $Ex$=0 holds only for $x$ on the equilibrium-path, then, by definition, (8.22) implies that we refrain from modelling irrational or out-of-equilibrium behaviour.

From (8.22) and the discussion about the choice of $x$ when B is of type 1, it is concluded that actual inflation in this case equals from (8.1a):

$$\pi_1 = \pi^* + (1-p)(1-q)\alpha(\beta-1)(P^* - Q) + \varepsilon - x_1^*.$$

Substituting for $x_1^* = \varepsilon$ in the above, the following is derived:

$$\pi_1 = \pi^* + (1-p)(1-q)\alpha(\beta-1)(P^* - Q). \tag{8.23a}$$

For $\alpha$>0 and $\beta$>1, which hold by assumption, from (8.23a) it is concluded that $\pi_1 > \pi^*$. Therefore, even a central bank that is exercising strict inflation-targeting monetary policy, cannot exercise perfect control over inflation expectations and actual inflation eventually, unless it can convince the financial sector that does so (leading to $p$=1, or $q$=1). This result demonstrates that uncertainty about the way a central bank conducts its policy may prove detrimental[204].

When B is of type 2, and is either on a pooling or a separating equilibrium, actual inflation will respectively take the following levels, using (8.1b) and (8.22):

$$\pi_2 = \pi^* + (1-p)(1-q)\alpha(\beta-1)(P^* - Q) + \varepsilon - x_2^* \overset{x_2^* = x_1^*}{\Rightarrow}$$

$$\pi_2 = \pi^* + (1-p)(1-q)\alpha(\beta-1)(P^* - Q), \tag{8.23b}$$

and

$$\pi_2 = \pi^* + (1-p)(1-q)\alpha(\beta-1)(P^* - Q) + \varepsilon - x_2^{**} \overset{(8.20)}{\Rightarrow}$$

[204] This result is similar to the main conclusion of Cukierman and Liviatan (1991), where "imperfect credibility [of the 'strong' policymaker (similar to B of type 1)] turns out to be partially self-fulfilling in the sense that the strong policymaker does not deliver the target inflation it would have delivered under perfect credibility" (Cukierman and Liviatan (1991), p. 101).

$$\pi_2 = \pi^* + \frac{\alpha(\beta-1)}{H}\left\{\left[1+\alpha(\beta-1)^2(1-p)(1-q)\right]\left(P^*-Q\right)+\beta\varepsilon\right\}. \quad (8.23c)$$

(8.23b) gives the same result as in (8.23a). In (8.23c), $\pi_2 > \pi^*$ for $\alpha$>0, and $\beta$>1, which hold by assumption, the latter at all times, and the former for B being of type 2. Comparing (8.23b) with (8.23c) for $\varepsilon$ equal to its average value (of zero), it is concluded that in a separating equilibrium B of type 2 inflates more than in a pooling equilibrium for $p(1-q)+q>0$, which holds by assumption for all $p,q\in(0,1]$ and for $p=0$ and $q\neq 0$, as well as $q=0$ and $p\neq 0$. The last two conditions identify respectively the cases when S is certain that B is of type 2 and will never choose a 'pooling' equilibrium, and that B will never pool in equilibrium whichever type it may be of.

<u>Choice of *R* at *t*=0</u>

We assume competition drives the expected value to $Q=k\sigma_P$, for $\sigma_P$ denoting the standard deviation of *P*, the profits per unit of currency obtained by S. At this level for expected profits, the market finds the chances of bankruptcy just acceptable.

From (8.9) and (8.12), the choice of *R* is governed by:

$$\begin{aligned} &Q = 2R - i_0 - r^* - E\pi \overset{(8.12)}{\Rightarrow} \\ &R = \tfrac{1}{2}\left(i_0 + r^* + E\pi + k\sigma_P\right). \end{aligned} \quad (8.24)$$

In choosing $R$, S takes into account the effect on $\sigma_P$, and therefore on $Q$, of how B will choose $x$.

For B of type 1, and for S assigning $p$=1, from (8.11) and (8.16):

$$\sigma_P = \beta\sigma_\varepsilon . \tag{8.25a}$$

When B is of type 2, S believes that, with probability $q$, $x$ is as in (8.16) and with probability (1-$q$), $x$ is as in (8.20). S believes that B is of type 1 with probability $p$ and of type 2 with probability 1-$p$. Therefore, also using (8.11), the variance of $P$ is generally determined as following:

$$\sigma_P^2 = \operatorname{var}\left[(\beta-1)x+\varepsilon\right]$$
$$\sigma_P^2 = \operatorname{var}\left[(\beta-1)\left[p+(1-p)q\right]x_1^*+(\beta-1)(1-p)(1-q)x_2^{**}+\varepsilon\right]$$

Substituting for $x_1^*$ and $x_2^{**}$ from (8.16) and (8.20), the above becomes[205]:

$$\sigma_P = \left[1+\alpha(\beta-1)^2(p+q-pq)\right]\frac{\beta}{H}\sigma_\varepsilon . \tag{8.25b}$$

Comparing (8.25a) with (8.25b) we conclude that for $p$=1 in (8.25b), $\sigma_P$ is equal to (8.25a), which is also the case for $q$=1, i.e. when S believes that a type 2 B will

[205] The actual computation is:

$$\sigma_P^2 = \operatorname{var}\left[(\beta-1)\left[p+(1-p)q\right]\varepsilon+(\beta-1)(1-p)(1-q)\frac{1-\alpha(\beta-1)}{H}\varepsilon+\varepsilon\right]$$
$$\sigma_P^2 = \left[\left[(\beta-1)\left[1-(1-p)+(1-p)q\right]+1\right]H+(\beta-1)(1-p)(1-q)\left[1-\alpha(\beta-1)\right]\right]^2\frac{1}{H^2}\sigma_\varepsilon^2$$
$$\sigma_P^2 = \left[\beta+\alpha\beta(\beta-1)^2-\alpha(\beta-1)^3(1-p)(1-q)-\alpha(\beta-1)^2(1-p)(1-q)\right]^2\frac{1}{H^2}\sigma_\varepsilon^2$$
$$\sigma_P^2 = \left[\beta\left(H-\alpha(\beta-1)^2(1-p)(1-q)\right)\right]^2\frac{1}{H^2}\sigma_\varepsilon^2$$
$$\sigma_P^2 = \left[1+\alpha(\beta-1)^2\left[1-(1-p)(1-q)\right]\right]^2\frac{\beta^2}{H^2}\sigma_\varepsilon^2 \Rightarrow (8.25\text{b}).$$

always pool. For both *p*, *q* equal to zero, S believes that B is of type 2 and will always separate. In this case:

$$\sigma_P = \frac{\beta}{H}\sigma_\varepsilon . \qquad (8.25c)$$

For any levels of *p* and *q* less than 1 (and for *p* and *q* non-zero and always positive), $\sigma_P$ lies between the levels in (8.25a) and (8.25b). Therefore, when B is of type 1, or when B manages to make S believe that it is of type 1 (*p*=1), as well as when it makes S believe that it will always pool in equilibrium (*q*=1) if it is of type 2, B succeeds in imposing a higher level of prudence to S. In these cases, S will estimate a higher level for $\sigma_P$ and, thus, evaluate a higher level for *Q*. This will necessitate higher expected profits to guarantee S's survival. This result implies that other than better control over inflation expectations B will have more incentives to pool in equilibrium when it aims at the objective of financial stability.

Above we have presented the equilibrium outcomes of the first stage-game. The state-game starting at *t*=0 is repeated infinitely, at *t*=1, *t*=2, …, with a discount factor of $\delta$ per period. Pooling in each stage-game improves control of inflation expectations defined at *t*=1 and maintains an option to pool in the future. Thus, the option of B to pool in the future will affect its current behaviour, as well as the formation of $E\pi$ and the behaviour of S overall. If B pools in the first stage then it 'keeps the option' in the next stage-games. If B chooses to play the 'separating' equilibrium, its identity is revealed. Then there is no uncertainty in the future and S will receive complete information about the central bank it interacts with. Therefore, B chooses the 'separating' equilibrium ever after.

Let the option to pool have value *V*. It follows that the option to pool at *t*=2, when the second stage-game (the first repetition of the game) ends with the move of B, discounted to *t*=1 has value $\delta V$. For type 2, pooling compared to separation lowers inflation expectations and maintains the option to pool in the future. B of type 2 chooses pooling in the first stage-game at *t*=1 if and only if:

$$U_2^* - U_2^{**} + \delta V \geq 0. \tag{8.26}$$

When the equality holds in (8.26) B is indifferent between pooling and separating. This case still constitutes an equilibrium. Different equilibria may arise for different levels of the parameters.

## 8.5 Discussion

In this section we discuss the different equilibria that may arise for different values of the determinants of (8.26). The most important case is the effect $\varepsilon$ has on (8.26) determining thus equilibrium behaviour. Initially, we need to consider the following.

***Lemma***

$$\frac{\partial}{\partial \varepsilon}\left(U_2^* - U_2^{**}\right) = -A_1\left(E\pi - \pi^*\right) - A_2\varepsilon - A_3\left(P^* - Q\right), \tag{8.27}$$

where $A_1, A_2, A_3 > 0$.

**Proof:** Recall $\alpha > 0, \beta > 1,$ and so $H > 1$, while also $P^* > Q$. Applying the envelope theorem:

$$
\begin{aligned}
&\frac{\partial}{\partial\varepsilon}\left(U_2^* - U_2^{**}\right) = \\
&= -2\alpha\beta\left[P^* - Q + (\beta-1)\left(E\pi - \pi^*\right) + \beta\varepsilon\right] + \\
&\quad + 2\left(E\pi + \varepsilon - x_2^{**} - \pi^*\right) + \\
&\quad + 2\alpha\left[P^* - Q + x_2^{**} + \varepsilon\right]
\end{aligned}
$$

$$
\begin{aligned}
= -2\Big\{&\left[\alpha\beta(\beta-1)-1\right]\left(E\pi - \pi^*\right) + \\
&+\left[\alpha\left(\beta^2-1\right)-1\right]\varepsilon + \alpha(\beta-1)\left(P^* - Q\right) + \\
&+\left[1-\alpha(\beta-1)\right]x_2^{**}\Big\}.
\end{aligned}
$$

Substituting from (8.20):

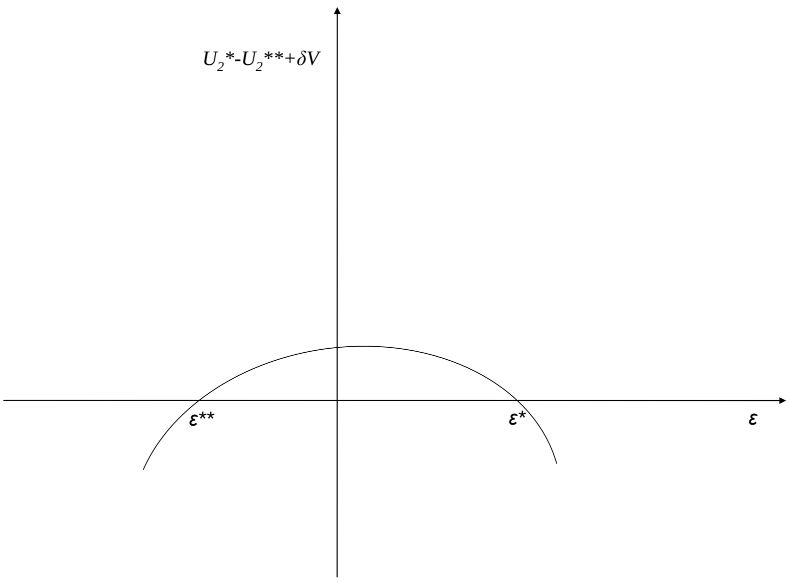
$$
\begin{aligned}
&\frac{\partial}{\partial\varepsilon}\left(U_2^* - U_2^{**}\right) = \\
&= -\frac{2}{H}\Big\{\left[1-\alpha(\beta-1) - H + \alpha\beta(\beta-1)H\right]\left(E\pi - \pi^*\right) + \\
&\qquad +\left[1-\alpha(\beta-1) - H + \alpha\left(\beta^2-1\right)H\right]\varepsilon + \\
&\qquad +\alpha(\beta-1)\left[H - 1 + \alpha(\beta-1)\right]\left(P^* - Q\right)\Big\}.
\end{aligned}
$$

$$
\begin{aligned}
= -\frac{2}{H}\Big\{&\left[\alpha^2\beta(\beta-1)^3\right]\left(E\pi - \pi^*\right) + \\
&+\alpha(\beta-1)\left[1+\alpha(\beta-1)^3\right]\varepsilon + \\
&+\alpha^2\beta(\beta-1)^2\left(P^* - Q\right)\Big\}.
\end{aligned}
$$

On the right hand side, the coefficients of $E\pi - \pi^*$, $\varepsilon$ and $P^* - Q$ are negative, which proves the lemma.

We can use the lemma in order to present the relationship between the variation of (8.26) with respect to the shock to inflation, $\varepsilon$. This is depicted in the following graph in Figure 8.2. The figure shows how the choice of B to pool or not is affected by the level of the shock to inflation. In particular, (8.26) has one term $\left(U_2^* - U_2^{**}\right)$ plus a constant. According to the lemma, integrating the right hand side of (8.27) with respect to $\varepsilon$, leads to a quadratic function. Therefore, the graphical representation of (8.26) is as the graph in Figure 8.2.

***Figure 8.2***




According to the lemma, there exist critical values for the shock to inflation, $\varepsilon = \varepsilon^{**} < 0$, and $\varepsilon = \varepsilon^*$, such that type 2 chooses pooling for $\varepsilon^{**} < \varepsilon < \varepsilon^*$ and separation for $\varepsilon < \varepsilon^{**}$ or $\varepsilon > \varepsilon^*$. Intuitively, separation is triggered by extreme shocks, more especially positive shocks. For the special case of $P^* = Q$, that also results in $E\pi = \pi^*$, the function depicted in Figure 8.2 is symmetric about the point (0,0) and would lie completely below the horizontal axis, which implies that $U_2^* - U_2^{**} + \delta V$ is always negative. Therefore, in this case B would always choose to separate, irrespective of the shock $\varepsilon$. In addition, as $P^*$ increases above $Q$, the graph in Figure 8.2 moves upwards and shifts to the left, increasing the number of 'pooling' equilibria.

The option value *V* is determined by:

$$V = q\left[ E\left(U_2^{*} - U_2^{**} \middle| \varepsilon^{**} < \varepsilon < \varepsilon^{*}\right) + \delta V \right]$$

$$V = \frac{q}{1 - q\delta} E\left(U_2^{*} - U_2^{**} \middle| \varepsilon^{**} < \varepsilon < \varepsilon^{*}\right). \tag{8.28}$$

For the special case of $P^{*} = Q$, *V* as in (8.28) is equal to zero. This is the case when B is indifferent between pooling and separating. In (8.28), *q*, the probability of B to pool is in fact the probability that $\varepsilon$ lies between $\left(\varepsilon^{**}, \varepsilon^{*}\right)$. From (8.26) and (8.28) it is concluded that as *q* increases the graph in Figure 8.2 shifts upwards increasing obviously the number of pooling equilibria.

## 8.5 Policy Implications

Modelling a situation of incomplete information can generate several insights concerning behaviour in competitive situations. Initially, it is evaluated whether a central bank shares a benefit in exploiting the lack of information about its preferences over aiming at financial stability in addition to low and stable inflation that the financial sector may face. It is shown that when suitable, a central bank that conducts pre-emptive monetary policy may prefer to pretend to act as a strict inflation targeting one. Pooling in this model is useful to a central bank because it succeeds in better control over inflation expectations. Similarly, a rule for monetary policy as the one defined in Chapter 7 is another way to achieve that control. Therefore, over the time-horizon that the true type of the central bank is not revealed the central bank can take advantage of this reputation without any binding commitment to a rule. The control over inflation expectations can be exercised because the financial sector is forward-looking and also aware of the presence of an 'option' (with value *V*) that may be exercised by the central bank.

Nevertheless, central banks tend not only to be concerned with inflation. When a central bank cares to maintain financial stability (as a foundation that enhances overall macroeconomic stability, as explained in Chapter 7), then for small shocks to inflation hitting the economy, the central bank prefers to build or retain a reputation as a strict- inflation targeting one. Conversely, when inflation shocks (positive or negative) have a large effect to inflation, the central bank reveals its additional concerns for financial stability by allowing a more muted reaction and accepting inflation higher than the targeted rate. We may, in turn, consider the growth of a bubble to be possibly reflected in a negative inflation shock. According to this model, a central bank can pre-empt this adverse situation only when the shock becomes very large. This result may qualify for a reluctance of central banks to deviate to a great extent from their targeted rate of inflation, unless adverse circumstances force them to use their instrument in order to reach their macroeconomic objectives (in our context defined in terms of financial stability).

Other than better control over inflation expectations this model shows that a central bank will also have more incentives to mimic in equilibrium a strict-inflation targeter when it aims at the objective of financial stability, because in this way it results in the financial sector being stricter in its operations (imposing a competitive requirement of higher expected profits to firms that want to remain in the sector).

Furthermore, the model demonstrates that even a central bank that is exercising strict inflation-targeting monetary policy, cannot exercise perfect control over inflation expectations and actual inflation eventually, unless it can convince the financial sector that it does so. This result demonstrates that uncertainty about the way a central bank conducts its policy may prove detrimental and advocates (the now consensus view) that communication of central bank's preferences over the conduct of policy is important, also when central bank conducts pre-emptive policy (in a discretionary way).

## 8.7 Concluding Remarks

The analysis in this chapter is an extension of the two-player game presented in Chapter 7 by modelling one player, the financial sector, as being confronted with incomplete information about the preferences of the other, the central bank. The model, in particular, incorporates a central bank that can either aim at the objective of low and stable inflation (solely) or face the dual objective of price and financial stability. The interaction can be repeated infinitely and, thus, the concerns that current behaviour affects future outcomes impose an effect on the choices of each player.

In this model since the financial sector is partially informed about the way the central bank conducts monetary policy, even a central bank that prefers to pre-empt financial instability may choose in equilibrium, for suitable levels of parameters, to mimic a 'strict inflation targeting' central bank. The aim is to build its reputation as such in stead of behaving in a way that would reveal its identity by choosing the strategy that maximises its objective function. In this way, it manages to better control inflation expectations, and have a firmer guarantee of the stability of the financial sector. It is finally proven that only for considerably large shocks to inflation, is the 'pre-emptive' central bank willing to exercise more muted control to inflation in order to reinforce the safety of the financial sector.

# CHAPTER 9

# CONCLUSIONS

## 9.1 Concluding Remarks

This chapter summarises the most important conclusions of the thesis while making an effort to discuss the relevance of this analysis within the context of the current global financial crisis that has severely affected the economies around the world.

A principal issue in the theories of the channels of transmission is the extent to which a policy-induced change in the official rate affects all short-term money market interest rates, and spreads, in turn, to the entire spectrum of interest rates, having an effect particular on the long-term interest rates that are most relevant to investment (including housing) or to purchases of durable goods. In fact, several factors affect the propagation of monetary policy actions along the term structure, including the organisation of financial markets and the state of expectations.

It appears plausible that monetary policy is able to have an effect on the real economy primarily because of interest rate effects and also, to a certain extent, because of asset-price effects. However, the recent empirical literature argues that in reality the effects of monetary policy, in particular those of a monetary contraction, are stronger than those which could be expected if the interest rate and asset-price channels were the only relevant mechanisms, and also that they exhibit a different pattern than the effects one would expect to encounter if these were the only pertinent mechanisms (Schmidt (2001), p. 212).

The dynamic process described in Chapter 2 involves a number of different mechanisms and actions undertaken by economic agents at various stages. Consequently, monetary policy actions need a considerable time to have an impact on price developments. Moreover, the size and intensity of the effects can differ with respect to the state of the economy, which renders the estimation of the precise impact considerably difficult. Central banks, thus, are facing long, variable and uncertain lags in the conduct of monetary policy. A further issue that complicates the transmission mechanism of monetary policy is that, in practice, a large number of shocks from several sources influence economic developments. Thus, in addition to monitoring the monetary transmission mechanism central banks need also to consider all other developments relevant to future inflation so as to prevent those from having an impact on longer-term inflation trends and expectations in a way inconsistent with price stability (ECB (2004), p. 47). As central banks face a complex environment of economic interactions, they often tend to consider some simple rules of thumb in order to guide or cross-check their action.

A convergence in the theory and practice of monetary policy has taken place since the early 1980s. On the policy side, there is a widely accepted desirability and feasibility of central banks to use monetary policy in order to achieve and maintain low inflation over time, and that such commitment to price stability enhances the power of monetary policy to stabilize employment over the business cycle. The focus on price stability emerged as a result of the practical experience in conjunction with the theory developed since late seventies (Goodfriend (2005), p. 250). Furthermore, the old tradition of central banks of opaqueness in their statements has been replaced with the widely accepted trend towards greater transparency, which enhances the effectiveness of monetary policy.

The 'benchmark model' (and the broad set of extensions) suggests a set of major conclusions about the role of monetary policy. A set of four main conclusions are emphasised by Goodfriend and King (1997): (i) "Monetary policy actions can have an important effect on real economic activity, persisting over several years, due to gradual adjustment of individual prices and the general price level. (ii) Even in settings with costly price adjustment, the models suggest little long-run trade-off between inflation and real activity. (iii) The models suggest significant gains from eliminating inflation, which stem from increased transactions efficiency and reduced relative price distortions. (iv) The models imply that credibility plays an important role in understanding the effects of monetary policy" (Goodfriend and King (1997), p. 232). They find these issues to be consistent with monetary policymakers' statements in several countries. Nevertheless, while it is deemed crucial for the monetary authorities to monitor developments regarding the connections between the policy rate and market rates (and asset prices), the consensus model (and proposed extensions), to our knowledge, fails to provide a widely accepted structural representation of the monetary and financial system and of their role in the transmission mechanism of monetary policy.

Furthermore, a generally accepted definition of the stability of a financial system has not yet emerged in the literature. Besides a tendency to define financial instability instead, there exists a clear distinction between definitions that refer to the volatility of directly observable financial variables and those that are based on a system approach. The latter tend to broadly follow Mishkin's (1991a), which can be adapted according to Issing (2003) to a broad, but intellectually convincing definition of financial stability as "the prevalence of a financial system which is able to ensure in a lasting way, and without major disruptions, an efficient allocation of savings to investment opportunities" (Issing (2003), p. 16). The degree of financial fragility can then be viewed as the proximity of the economy to a critical point, exceeding which would impair the efficient allocation of savings (Issing (2003), p. 16).

Volatility in asset prices seems to be a symptom rather than a cause of the boom-bust cycle, and, therefore, monetary policymakers need principally to address any monetary policy problems that may potentially create economic instability. It is argued (see Goodfriend (2001)) that equity prices, in fact, constitute a misleading guide for interest-rate monetary policy, which needs to protect market liquidity and maximise a central bank's leverage over longer-term interest rates and aggregate demand. Monetary policy is also argued to be a fundamental source of deflation and stagnation risk in a regime of fully credible price level stability. A central bank can actually be insufficiently pre-emptive in a business expansion, being misled by its own credibility for low inflation.

According to Hunter, Kaufmann and Pomerleano (2003) asset price bubbles can (at least partly) be attributed to "wealth effects in household consumption – rising perceptions about the future growth of incomes, increasing creditworthiness of households, and changes in corporate investment as a result of falling cost of new capital, rising expectations about future growth of earnings, and greater perceived creditworthiness of firms" (Hunter, Kaufmann and Pomerleano (2003), p. 26)[206].

Mishkin and White (2003) suggest that "because stock-market crashes are often not followed by signs of financial instability, we must always be cautious about assigning causality from timing evidence, while certainly, one cannot make the case that stock-market crashes are the main cause of financial instability" (Mishkin and White (2003), p. 73). In fact, in several such episodes it is argued that the source of financial instability might have been other factors, such as the collapse of the banking system or the severity of the economic contraction. The theory of how stock-market crashes can interfere with the efficient functioning of financial markets suggests that the impact of a stock market crash will be very different depending on the initial conditions of balance sheets in the economy.

Asset-price booms and busts have, historically, suggested that their impact on the real economy varies. The most costly episodes in social and economic terms tended to be those accompanied by high leverage and a large build-up in credit. Asset-price bubbles are an especially difficult topic as they tend to be difficult to explain, in part

[206] As Mishkin (2008) points out, financial history shows a sequence of events that typically proceed in the following manner. Stemming from either excessive optimism about economic prospects or fundamental changes in the structure of the financial system, a boom in credit provision takes place, which leads to higher demand for certain assets and, in turn, to higher prices for those assets. The latter raises the values of those assets, consequently, promoting further issuing of credit backed by those assets, which further raises demand and, thus, the prices of those assets. Such a reinforcing mechanism can create a bubble. The latter can encourage lax credit standards since lenders rely more on the further appreciation of the pertinent assets (in order to shield themselves from potential loss) than on the borrowers' ability to repay the debt issued to them. When the bubble (inevitably) bursts the mechanism described above works backwards. The drop in asset prices causes a decrease in the supply of credit, and as the demand for assets continues to fall their prices drop further. Loan defaults and the slump in asset prices deteriorate the balance-sheet positions of financial institutions leading to a further decrease in credit supply and investment. Business and household spending shrinks as a result of the decline in lending. In turn overall economic activity deteriorates and macroeconomic risk in credit markets increases. Finally, "in the extreme, the interaction between asset prices and the health of financial institutions following the collapse of an asset price bubble can endanger the operation of the financial system as a whole" (Mishkin (2008), p. 2).

just as history is difficult to explain, since a huge variety of forces shapes historic events. Bubbles are also difficult to explain, relative to other historic events, since they involve a complex interaction in which people try very hard to outsmart each other. Notably, Shiller (2003) points out differences in approach to research on asset-price bubbles when he writes “microeconomists still rarely cite macroeconomists, economists rarely site psychologists, and academics rarely site news media stories.” Therefore, he further remarks that the research on asset-price bubbles, in general, yields fragmentary conclusions (Shiller (2003), p. 36).

Because of their potential effect on price and financial stability the developments in asset prices are a serious cause of concern for monetary policymakers. Nevertheless, at least two main reasons stand out against the introduction of asset prices into a central bank’s monetary policy reaction function. These reasons are, first, that asset prices are difficult to determine scientifically, and, second, that if they were to constitute indicators of monetary policy, since they are highly volatile, they would render the implementation of sound monetary policy very difficult[207].

It has been presented that a hotly debated issue for both policymakers and academics is the relationship between asset prices and monetary policy. It does not seem to be disputed that a sharp decline in asset prices can be disruptive. In addition, for example, Bernanke (2000), and Kohn (2006) point towards a broad agreement that failure to deal decisively with financial system weakness is a major policy mistake.

[207] As Trichet (2003), for example, emphasizes, other than using monetary policy, the functioning of the financial system can be improved through measures enhancing market transparency and reducing herding behaviour. Propositions include improvements on regulatory accounting measures, tax rules and regulations, as well as of codes of good conduct and good practice.

Yet, Gaspar and Kashyap (2006) remark that the issue of what to do when faced with a large increase in either equity prices or house prices still remains contentious.

On this issue, Hunter, Kaufmann and Pomerleano (2003) send potentially vital messages to monetary policymakers in their effort to devise a monetary policy plan of action, so as to protect against asset-price bubbles or mitigate their impact. They arrive at the following general conclusions: (i) It is very difficult for monetary policymakers to identify asset-price bubbles when they develop, due to constraints of imperfect information, downside risks of misusing instruments, limited effectiveness of policy instruments, and time constraints. (ii) Even though crises frequently follow asset-price bubble collapses, not all cases result in crises that create financial system instability. Financial systems, which operate (before the development of a bubble) under solid supervisory and regulatory institutions and macroeconomic stability have proven to be more resilient to the unwinding of a bubble than systems not having the above features. In this respect, asset-price bubbles followed by costly crashes tend to be more frequent in emerging, rather than developed, economies where financial markets tend to be more opaque, supervision and regulation are rather poor, and lending is mainly based on collateral instead of expected cash flow projections (as a result primarily of poor accounting standards). (iii) Weak macroeconomic policies, insufficient policy transparency and micro-structural weaknesses encouraging the development of asset-price bubbles, tend to exist in economies that experience crashes that last longer, bear higher costs and are more destabilising. This points towards the establishment of an effective prudential regulatory regime to safeguard the financial system from the adverse consequences of a crisis, rather than attempts at an appropriate and prompt identification of asset-price bubbles. (iv) Potential agency problems and information asymmetries are minimised by transparency. Thus, it is important to enhance the development and enforcement of accounting and auditing standards, including the frequency and means of dissemination and the quality of disclosure. (v) More diversified financial systems tend to spread risks and counter the consequences of the unwinding of bubbles better than less diversified ones. It thus seems important to encourage the development of risk-transfer instruments, like index funds, securitized assets, stock borrowing, lending, and short-selling regimes, and regulated futures and derivatives markets, in order to allow for heterogeneity in investors' attitudes and enable investors' hedging against asset-price bubbles. (vi) Since solid regulatory and supervisory institutions tend to be the 'best line of defence', it is important for a central bank to maintain its credibility and reputation in executing its core function of preserving macroeconomic stability (Hunter, Kaufmann and Pomerleano (2003), p. 25).

Historical episodes illustrate the challenges bubbles in asset prices pose to monetary policymakers, since they tend to evolve quickly and produce very high costs to the overall economy when they burst. As they are difficult to recognise promptly, they tend to be identified only ex post. Nevertheless, even though research provides conflicting tools enabling the early identification of asset-price bubbles, it is still vital for monetary policymakers to monitor movements in asset prices in an attempt to preserve consumer-price stability over longer horizons.

In the thesis, after debating the inclusion or not of perceived financial imbalances in the conduct of monetary policy before the forecasts to inflation are affected, we evaluate monetary policy that is conducted pre-emptively against financial instability in a simple model of the strategic interaction between a central bank and a financial sector. The central bank has the objectives of price stability and financial stability, and the latter is a function of the profitability of the financial sector relative to a benchmark. In line with the results proposed in the extant literature in favour of pre-emptive monetary policy that calls for more flexibility and the use of longer time-horizons in the conduct of monetary policy, we assess monetary policy under discretion and under commitment to an instrument rule. Similar to the literature initiated with Barro and Gordon (1983), yet in the new context proposed, the analysis concludes: The optimal policy should be conducted under commitment to a rule, contrary to the propositions of the relevant literature. In this case, policy is more effective in controlling inflation, and given substantial information on risks to financial stability, induces the financial sector to impose prudence on itself.

The model is extended to incorporate uncertainty about the objectives of the central bank. In a model where the player making the first move, i.e. the financial sector, is uninformed about whether the central bank faces the objective of price stability or the dual objective of price and financial stability (where the latter is described in the basic model in Chapter 7 as monetary policy which is 'pre-emptive' against financial imbalances), different kinds of equilibrium are derived. The main conclusion reached in the extended model is that, since the financial sector does not know what type of central bank it faces, when the central bank conducts policy pre-emptively against financial instability, it may choose in equilibrium, for suitable levels of parameters, to mimic a 'strict inflation targeting' central bank. The aim is to build its reputation as such, thus affect inflation expectations in the future, and have an impact on the stability of the financial sector. It is finally shown that only for large shocks to inflation is the ‘pre-emptive’ central bank willing to exercise more muted control over inflation in order to reinforce the safety of the financial sector.

## 9.2 The Global Financial Crisis

In the following analysis we discuss the relevance of our conclusions in the light of the current global financial crisis initiated in August 2007 that is “weighing heavily on economies around the world” (Kohn (2008), p.1), and which severely affected the cost and availability of credit to firms and households in several countries. Economic and financial linkages across countries rendered the current crisis global in scope, having a severe impact on both developed and developing economies. The worldwide economic disruption is thus deemed to be considerably more severe than in similar episodes in the past. Especially in the US, from where it initiated, it is considered “the worst [financial crisis] since the Great Depression” resulting in extensive constraints in the flow of credit, termed “the lifeblood of market economies”, and immense overall damage to the economy[208] (Bernanke (2009), p.1).

In particular, being in the midst of the global financial crisis, most economies are currently facing a major shock to the financial system that started from the problems inherent in the US subprime mortgage market (where subprime is the term for mortgages offered to less-creditworthy borrowers), and which eventually contaminated securitization products and credit markets more generally. Currently,

[208]In particular, in the US several families are struggling with lost employment and depleted savings or property foreclosure, while several enterprises cancelled construction projects and shut down factories. In addition, local governments and municipalities hardly manage to fund critical services. Finally, the impact that the crisis is having almost everywhere in the world should not be overlooked (Bernanke (2009), p. 1).

banks face the need to absorb a higher amount of risk than has typically been the case (by moving off-balance sheet assets onto their balance sheets), yet the losses suffered already limit their ability to do so. Aggregate risk capacity in the financial system has eventually been reduced – a bank credit crunch caused by a scarcity of equity capital in banks – since losses urge those typically used to absorbing risk to face the need to limit such exposures. A significant amount of capital has been raised by banks in order to partly offset write-downs and credit losses. However, "credit losses in the banking book will begin to rise… and banks are entering this phase with weakened balance sheets. Alongside a rise in credit related losses, the outlook for bank profitability is poor" (Draghi (2008), p. 1).

Despite the highly uncertain outlook, it is recognized that the financial system fragility and the weakness in real activity are likely to persist for a while. As private lenders have become unable or even reluctant to enable the flow of credit in several economies, central banks in the pertinent countries have responded by easing monetary policy to a great (at times unprecedented) extent and expanded their lending so as to promote maximum sustainable economic growth and price stability. Furthermore, extraordinary actions have been taken by governments around the world in order to strengthen financial systems and preserve firms' and households' borrowing and spending ability (see e.g. the Report on the G20 meeting on April 2, 2009). It is now the common view that "the current situation is so severe that it calls for careful review of how such a crisis evolved and how we can prevent a similar situation from happening again" (Kohn (2008), p. 1), since as it unfolds "it has evolved into an even more complex combination of rising inflation, declining growth, tightening credit conditions, and widespread liquidity tensions pervading the global financial industry" (Draghi (2008), p. 1).

Nevertheless, we must admit that only a complex answer can be given in any effort to find out the causes of such an extensive financial and economic system collapse. While there is considerable disagreement about the weight that can be given to every explanation, Bernanke (2009), for example, stresses that "to understand its international scope, we need to consider how global patterns of saving and investment have evolved over the past decade or more, and how those changes affected credit markets in the U.S. and some other countries" (Bernanke (2009), p. 1). Accepting that in a global financial system, saving can be generated from foreign as well as domestic sources, he contends that "much of this foreign saving came from fast-growing emerging market countries in Asia and other places where consumption has lagged behind rising incomes, as well as from oil-exporting nations that could not profitably invest all their revenue at home and thus looked abroad for investment opportunities[209] … the housing boom in the U.S. being one important consequence, and a boom that was fuelled in large part by a rapid expansion of mortgage lending. Unfortunately, much of this lending was poorly done"[210] (Bernanke (2009), p. 2). He further accepts that "regulators did not do enough to prevent poor lending, in part

[209] According to Bernanke (2009) the net inflow of foreign saving to the U.S. was roughly 1,5% of the U.S. national output in 1995, and reached about 6 % of U.S. national output in 2006, an amount equal to about $825 billion in current dollar prices (Bernanke (2009), p. 2).

[210]Bernanke (2009) points out that "lending involved, for example, little or no down payment by the borrower or insufficient consideration by the lender of the borrower's ability to make the monthly payments. Lenders may have become careless because they, like many people at the time, expected that house prices would continue to rise – thereby allowing borrowers to build up equity in their homes – and that credit would remain easily available, so that borrowers would be able to refinance if necessary" (Bernanke (2009), p. 2).

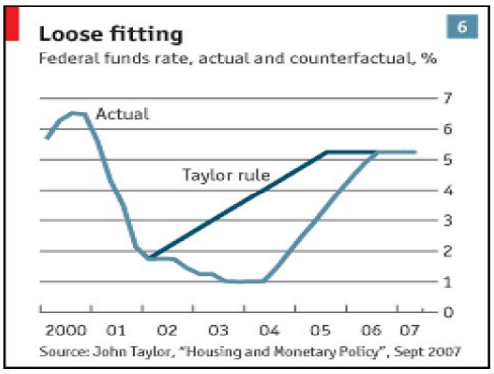
because many of the worst loans were made by firms subject to little or no federal regulation”[211] (Bernanke (2009), p. 2).

Thus, Bernanke (2009), among others, argues that the low interest rates in 2002-2004 were caused by global factors beyond the control of the monetary authorities, the interest rate decisions by the monetary authorities not being the major factor causing the boom. Taylor (2009) finds the appeal of such an explanation that focuses on global saving to lie in the fact that long-term interest rates were low for a while even after the short-term federal funds rate started increasing. The cause identified is that there was an excess of world saving, usually termed as a global saving glut, which pushed interest rates down in the U.S. and other countries[212] (Taylor (2009), p. 4).

[211] Bernanke (2009), however, recognises the following: “mortgage markets were not the only ones caught up in the credit boom. The large flows of global saving into the U.S. drove down the returns available on many traditional long-term investments, such as Treasury bonds, leading investors to search for alternatives. To satisfy the enormous demand for investments both perceived as safe and promising higher returns, the financial industry designed securities that combined many individual loans in complex hard-to-understand ways. These new securities later proved to involve substantial risks – risks that neither the investors nor the firms that designed the securities adequately understood at the outset” (Bernanke (2009), p. 2).

[212] Taylor (2009) stresses that “the classic explanation of financial crises, going back hundreds of years, is that they are caused by excesses – frequently monetary excesses – which lead to a boom and an inevitable bust… in the recent crisis we had a housing boom and bust which in turn led to financial turmoil in the U.S. and other countries” (Taylor (2009), p. 1). He argues that monetary excesses were the main cause of that boom and the resulting bust and uses Figure 9.1 to illustrate in a simple way the story of monetary excesses, in particular examining US Federal Reserve policy decisions – in terms of the federal funds interest rate – from 2000 to 2006 (Taylor (2009), p. 1, 2).

**Figure 9.1**




Source: Taylor (2009), p. 2.

However, according to Taylor (2009) "the main problem with this explanation is that there is actually no evidence for a global saving glut[213]… [and] this alternative explanation does not stand up to empirical testing using data that have long been available" (Taylor (2009), p. 4). Taylor (2009) provides (preliminary) empirical evidence that government actions and interventions caused, prolonged, and worsened the financial crisis[214]. He remarks, though, that "there are and will continue to be differences of opinion", while "carefully documented empirical research is needed

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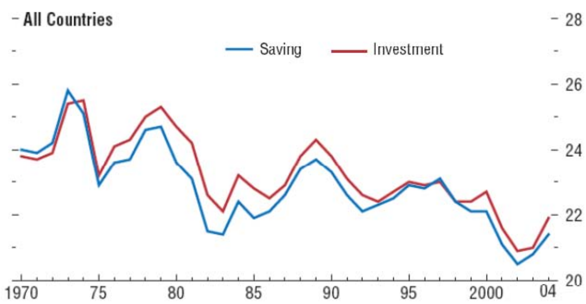
Figure 9.1 demonstrates that actual interest rate decisions deviated to a great extent from the Taylor rule, providing "an empirical measure that monetary policy was too easy during this period… [and that in fact] there was no greater or more persistent deviation of actual Fed policy since the turbulent days of the 1970s" (Taylor (2009), p. 2). Taylor (2009) further remarks that "there is clearly evidence that there were monetary excesses during the period leading up to the housing boom" recognising that "the unusually low interest rates decisions were, of course, made with careful consideration by monetary policymakers, … [possibly interpreted] as purposeful deviations from the "regular" interest rate settings based on the usual macroeconomic variables" (Taylor (2009), p. 3).

[213] Figure 9.2 gives simple evidence that there seems to be a saving shortage, showing that the global saving rate (measured as global saving being a fraction of world GDP) reached a considerably low level during 2002-2004 especially when compared with the 1970s and 1980s.

**Figure 9.2: Global Saving and Investment as a Share of World GDP**




Source: *World Economic Outlook*, IMF Sept 2005, Chapter 2, p. 92 (from Taylor (2009), p. 4).
Taylor (2009) accepts the presence of a "gap of saving over investment in the world *outside* the U.S. during 2002-2004" and argues that during this period the US was actually running a current account deficit, implying that saving was less then investment (Taylor (2009), p. 5). He remarks that a negative saving gap in the US was offset by an equal sized positive saving gap outside the US. In this case world interest rates would not be expected to change (Taylor (2009), p. 5).

[214] Taylor (2009), recognising that this particular research must be considered preliminary and being in the middle of the crisis there is a need to collect and analyse more data, points out that in particular "… they caused it by deviating from historical precedents and principles for setting interest rates, which had worked well for 20 years. They prolonged it by misdiagnosing the problems in the bank credit markets and thereby responding inappropriately by focusing on liquidity rather than risk. They made it worse by providing support for certain financial institutions and their creditors but not others in an ad hoc way without a clear and understandable framework. While other factors were certainly at play, these government actions should be first on the list of answers to the question of what went wrong" (Taylor (2009), p. 18).

for sorting out these differences", and that, finally, "we should be basing our policy evaluations and conclusions on empirical analyses not ideological, personal, political, or partisan grounds" (Taylor (2009), p. 18).

The sequence of events relevant to the shock in the US subprime mortgage market as well as its spread is described, for example, in IMF (2008), de Larosière Report (2009) and several press accounts, that need not be reviewed in this section. Around the beginning of 2007 problems surfaced with subprime mortgages and house prices in parts of the U.S. began to fall[215] (Bernanke (2009), p. 2). Essentially, it became evident very quickly during the late summer and early fall of 2007 that rapid losses were increasingly taking place on the large amount of subprime mortgages that had been originated in the previous three years, and that the models used in order to estimate the risks on those mortgages had hugely underestimated potential losses. The structures of the securities are too complex to enable the evaluation of the precise size of the future loss (Gorton (2008)) and, in addition, these new products have limited track records, especially in a declining house price environment.

Greenspan (2009) gives the following account of the story: "all the sophisticated mathematics and computer wizardry essentially rested on one central premise: that the enlightened self-interest of owners and managers of financial institutions would lead them to maintain a sufficient buffer against insolvency by actively monitoring

[215] Bernanke (2009) gives a briefing of the sequence stating in the following: "Mortgage delinquencies and defaults rose, and the downturn in house prices intensified trends that continue today. Investors, stunned by losses on assets they had believed to be safe, began to pull back from a wide range of credit markets, and financial institutions – reeling from severe losses on mortgages and other loans – cut back their lending. The crisis deepened in September 2008, when the failure or near-failure of several major financial firms caused many financial and credit markets to freeze up. Stock prices fell sharply as investors lost confidence in the financial sector and became gloomy about economic prospects. Declining stock values, a teetering financial system, and difficulties in obtaining credit triggered a remarkably rapid and deep contraction in global economic activity and employment, a contraction that has persisted through the first months of 2009" (Bernanke (2009), p. 2).

their firms' capital and risk positions. For generations, that premise appeared incontestable but, in the summer of 2007, it failed. It is clear that the levels of complexity to which market practitioners, at the height of their euphoria, carried risk-management techniques and risk-product design were too much for even the most sophisticated market players to handle prudently" (Greenspan (2009), p. 1).

In fact, both the current financial turmoil and the subsequent contraction in economic activity are a major concern to economic policymakers[216]. However, as Bernanke (2009) remarks, due to the problems credit markets in most economies experience, conventional monetary policy alone seems inadequate to bolster the economy now that is most necessary (Bernanke (2009), p. 2).

The important lesson gained from the current events is the inability of financial regulators to fully or accurately forecast the depth and extent of financial fragility or even the advent of a financial crisis. According to Greenspan (2009) supervision and examination can implement and enforce, for example, capital and collateral requirements, in addition to other rules that are preventative and do not require the anticipation of an uncertain future. In particular, it has been successful in restraining certain types of bank lending, such as commercial real estate. Mishkin (2009) points

[216] Greenspan (2009) further argues that "even with the breakdown of self-regulation, the financial system would have held together had the second bulwark against crisis – i.e. the regulatory system – functioned effectively; but, under crisis pressure, it too failed" (Greenspan (2009), p. 1). He states that just a year before the crisis started the Federal Deposit Insurance Corporation had noted that "more than 99 per cent of all insured institutions met or exceeded the requirements of the highest regulatory capital standards" (quoted in Greenspan (2009), p.1) and remarks that even though banks in the US operate under rather severe regulation and also 10 to 15 of the largest ones had daily operations overseen by on-site examiners, still many of them "took on toxic assets that brought them to their knees" (Greenspan (2009), p. 1). He further highlights that "the UK's heavily praised Financial Services Authority was unable to anticipate and prevent the bank run that threatened Northern Rock, [while] the Basel Committee, representing regulatory authorities from the world's major financial systems, promulgated a set of capital rules that failed to foresee the need that arose in August 2007 for large capital buffers" (Greenspan (2009), p. 1).

out that “the focus on individual institutions can also cause regulators to overlook important changes in the overall financial system” and as an example he states that “although the markets for securitised assets and the shadow banking system of lightly regulated financial institutions grew dramatically in the years before the current crisis, the existing regulatory structures did not evolve with them” (Mishkin (2009), p. 1)[217].

Nevertheless, as Greenspan (2009) argues “competition, not protectionism, is the source of capitalism’s great success over the generations … [and, therefore] regulation should enhance the effectiveness of competitive markets, not impede them”[218] (Greenspan (2009), p. 2). Reshaping financial regulation with the aim to stabilise the system is certainly of primary concern. However, it is argued that “ill-thought-out calls in the heat of the moment for more safeguards and expensive compliance may tend mainly to increase concentration and reduce competition. The trend is clear: two years ago Europe’s 45 biggest banks held 66% of bank deposits. Now 40 of them hold 70%” (*The Economist*, 6th June 2009, p. 35).

It is important to stress, however, that bubbles (that at some point tend to be driven by euphoria) seem to require prolonged periods of low long-term interest rates, damped inflation and prosperity overall. Greenspan (2009) elaborating on this point

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[217] Greenspan (2009) remarks though that typically regulation, apart from often being costly and counterproductive, tends to fail the test of improving the ability of financial institutions to direct a nation’s savings into the most productive (welfare improving) capital investments (Greenspan (2009), p. 2).

[218] Recent experience shows that certain financial institutions are in fact ‘too big to fail’ since their failure would potentially give rise to adverse systemic consequences. This experience gives rise to new regulatory challenges according to Greenspan (2009). Such a status provides these institutions with a competitive advantage in pricing their debt and equities that he views as “highly market distorting”. The solution he suggests is graduated regulatory capital requirements that may discourage these institutions from becoming too big and that will offset their competitive advantage. Nevertheless, such remedial action should not be rushed upon private markets that are currently imposing far greater restraint than any of the current regulatory proposals would (Greenspan (2009), p. 2).

emphasizes the following: “History also demonstrates that under-priced risk – the hallmark of bubbles – can persist for years. I feared irrational exuberance in 1996, but the dotcom bubble proceeded to inflate for another four years. Similarly, I opined in a federal open-market committee meeting in 2002 that it’s hard to escape the conclusion that ... our extraordinary housing boom ... financed by very large increases in mortgage debt, cannot continue indefinitely into the future. The housing bubble did continue to inflate into 2006” (Greenspan (2009), p. 2). He further stresses that, traditionally, it is not demanding to judge when risk is historically underpriced, since a reliable guide is given by credit spreads. Informational disadvantages, however, render impossible to date an accurate anticipation of the onset of a crisis. Greenspan (2009) highlights that “financial crises are defined by a sharp discontinuity of asset prices…that requires that the crisis be largely unanticipated by market participants” and it is worth mentioning that “it was the excess securitisation of US subprime mortgages that unexpectedly set off the current solvency crisis” (Greenspan (2009), p. 2).

According to Greenspan (2009) an event needs to run counter to conventional wisdom on the ‘appropriate’ workings of the financial system in order to shock the markets. Being confronted with uncertainty, the financial community tends to resort to dramatic sales and, therefore, lower prices of goods and assets. He points out that “we can model the euphoria and the fear stage of the business cycle”, even though “their parameters are quite different” and concludes that, nevertheless, “we have never successfully modelled the transition from euphoria to fear” (Greenspan (2009), p. 2).

According to Ferguson (2004), public-policy action should address market volatility and institutional stresses need only when the latter are resulting from, and interact with, more-fundamental market failures which are highly likely to impair real macroeconomic performance. He stresses that when public policies constitute of increased regulation of financial markets, institutions and instruments in order to avoid the likelihood of financial stress “almost surely entail a significant cost measured in terms of increased moral hazard, lower economic growth, and financial markets that do not always allocate resources to their most productive use” (Ferguson (2004), p. 2).

The health of the financial system is an inherent concern of central banks. Since the financial system allocates capital and risk to the economy, it affects the achievement of primary macroeconomic objectives, such as stable prices and sustained growth. It is also key to the effective transmission of monetary policy decisions to the real economy (Draghi (2008), p. 9).

In addition, as Ferguson (2004) remarks “central banks have a long history of working to foster efficiency and stability in the global financial system, … [and, in fact] that traditional role has become more complex over time as the institutional and market realities of the financial system have evolved” (Ferguson (2004), p. 7).

Greenspan (2009) adds on this point: “I do not question that central banks can defuse any bubble. But it has been my experience that unless monetary policy crushes economic activity and, for example, breaks the back of rising profits or rents, policy actions to abort bubbles will fail. I know of no instance where incremental monetary policy has defused a bubble” (Greenspan (2009), p. 2). Therefore, it is vital to work towards the recovery of the financial system before devising the optimal type of a new regulatory structure[219].

According to Kohn (2008), however, "the severe fallout may indicate a larger potential gain than anticipated to leaning against excess exuberance in asset markets … realising [though] that potential rests on meeting the two further conditions … [namely] the timely identification of the bubble, and the ability of a central bank to materially influence the trajectory of the speculative component of asset prices" (Kohn (2008), p. 3). The way events have unfolded urge one to the conclusion that some kind of pre-emptive monetary policy as modelled in the thesis is necessary so as to lessen the likelihood of similar crisis episodes occurring in the future, after the pertinent economies recover from the current crisis. Moreover, our results, especially the superiority of such monetary policy when conducted under commitment to a rule (as analysed in Chapter 7), render the above two conditions highlighted by Kohn (2008) redundant. Instead of the identification of a bubble in a timely manner, we show that central banks will benefit from defining an appropriate monetary policy rule that will give them the ability to influence the behaviour of the financial sector. Since a rule that is well defined is a considerably operational tool for central banking practitioners, future research is necessary on that direction.

[219] Greenspan (2009) views that the recovery of the banking system in the US is essential to global rebalancing. He accepts that the troubled asset relief programme (following the Lehman Brothers default), the actual purchase of \$250bn (€185bn, £173bn) of preferred stock of US commercial banks under from the US Treasury had been successful in reducing the risk of US bank insolvency. Yet, the improvement has stalled at the absence of further investments from the US Treasury. He argues that "the restoration of normal bank lending by banks will require a very large capital infusion from private or public sources" and reports that the US consolidated bank balance sheet shows a future loss of at least \$1,000bn of US commercial bank assets at original book value out of the more than \$12,000bn (Greenspan (2009), p. 2).

In fact, ECB policymakers are currently debating whether ‘to lean against the wind’. Papademos stresses: “The conclusion, that we have incorporated into our thinking, is that development in asset prices should be monitored very closely… a policy of leaning against the wind of excesses deserves close thinking”. He also remarks: “The current ECB price stability objective would allow raising rates if an asset price bubble were forming, even if inflationary pressures were subdued” (reported from Reuters, Jun 2, 2009). Weber, who heads the German Bundesbank, also agrees that leaning against the wind could help to avoid a boom-and-bust cycle and adds that “such an approach could be used when money and credit growth is dynamic, asset prices go up and risk perceptions decline… [additionally] central banks should take a longer-term perspective which takes due account of the future inflationary consequences of such unfavourable developments… [which] could be achieved by monetary and credit analysis” (reported from Reuters, Jun 2, 2009).

The common objection to ‘leaning against the wind’ is the considerable costs it may incur in terms of real economic activity (as, for example, a significant damage to collateral values). However, the advocates of this style of policy refute this by proposing that policymakers should look at inflation over longer horizons. While the models analysed in Chapters 7 and 8 do not incorporate structural representations of the real sector so as to demonstrate a certain measure of the costs of pre-emptive monetary policy in terms of real activity, they generate some insights into the pertinent issues of concern to policymakers.

In particular, Chapter 8 shows that ‘leaning against the wind’ is not optimal when the financial sector is uncertain as to whether the central bank will conduct such a policy, indicating also the importance of transparency in monetary policy. The policy of 'leaning against the wind' implies raising interest rates in order to deflate asset price bubbles before they burst, even though consumer price inflation does not pose a significant threat. This policy is similar to what we term 'pre-emptive policy under discretion' in Chapters 7 and 8. Chapter 8 shows that when a central bank prefers to conduct the above style of policy but is not willing to publicly announce it, the agents that are strategically interdependent with it and are prone to aptly adjust their behaviour, i.e. the financial sector, will be worse off than in the absence of such uncertainty. Chapter 8 also demonstrates that, even when the central bank projects its behaviour to a long time horizon (mathematically infinite) – to the knowledge of the participants of the financial sector – it is only when large shocks to inflation occur that a central bank inclined to 'lean against the wind' is actually expected to do so. Otherwise, this style of policy will not be chosen and the central bank will mimic the inflation targeting central bank. Therefore, without a clear commitment to 'leaning against the wind' central banks will be expected to conduct this style of policy only when large inflationary shocks are likely. Yet, for a central bank to consider 'leaning against the wind' of excess exuberance in financial markets, inflation forecasts, the traditional monetary policy indicator, should not signal any threat. Therefore, this type of policy is sustainable only when the central bank credibly commits to it.

Additionally, Chapter 7 extends the analysis in considering not only an operational 'leaning against the wind' monetary policy (substituting the central bank objective of macroeconomic stability by an effective financial stabilisation objective[220] that does

[220] The financial stabilization objective proposed in Chapter 7, also used in Chapter 8 concerns the 'gap' that relates the profitability of the financial sector measured as a spread between long and short rates and a reference level.

not necessitate the identification of bubbles), but also a simple rule for monetary policy. The results in Chapter 7 in favour of commitment to a rule show that a central bank can conduct pre-emptive monetary policy in a way that avoids the hazard of a longer policy horizon.

Even though a short-term interest rate is under the direct control of central banks, long-term interest rates and other asset prices are largely determined by future policy expectations. A clear understanding of the central bank objectives and the way it implement future policy in response to economic developments are necessary for these expectations to be formed. Furthermore, when the central bank operates in a predictable way in response to economic developments, market expectations tend to remain anchored in the face of various shocks. Investors understand and take account of the central bankers' commitment to key long-run objectives such as price stability and sustainable economic growth (Ferguson (2004), p. 4). Ferguson (2004) makes an early remark of current concerns for monetary policy makers, which is: "Although central bankers can use predictable policy actions and the forward-looking nature of financial prices to their advantage, they must also be mindful of the potential market reactions to policy actions that are not fully anticipated or that may be misinterpreted. This, too, is an aspect of monetary policy that may become more prominent given the evolution of financial markets in recent years" (Ferguson (2004), p. 4). Commitment of the central bank to a rule similar to the one proposed in Chapter 7 should at least discourage the financial markets from any behaviour stemming from such misinterpretations.

Another important issue highlighted by the recent experience and relating to the procyclicality characterising the financial system is according to Draghi (2008) “the role that unusually easy global credit conditions over many years had in the build up of the current turmoil” (Draghi (2008), p. 10). There is a clear asymmetry between the two phases of boom-bust cycles. Even though the adverse consequences of the bust phase always tend to be obvious, it is difficult for policymakers to identify the build-up of imbalances during the boom phase. The underlying reason is that several factors, which are not necessarily related to imbalances, influence asset prices and balance sheet positions, and, in addition, not all booms result in a bust. It thus seems common to central banks to devise appropriate ways to intervene after the crash, by injecting liquidity in order to avoid a financial crisis, or even loosening monetary policy so as to avoid deflation, but remain passive during the boom phase (Draghi (2008), p. 10). The problem posed by a monetary policy with such a passive role is that it may increase moral hazard and increase the potential of further and more acute imbalances in the future. According to Draghi (2008) “the key challenge is therefore to understand whether monetary policy can or should be more proactive and ‘lean against the wind’ also in periods of growing financial imbalances in a pre-emptive manner, even in the absence of immediate threats to price stability – this is an open issue on which opinions diverge” (Draghi (2008), p. 11). Our results in favour of commitment to a rule demonstrate a symmetry in the policy design (similar to all styles of rule-based policy) reducing the likelihood of moral hazard behaviour.

Currently, it is particularly important for central banks to achieve a clear separation of roles and a correct assignment of instruments to objectives, due to the occurrence of inflationary pressures combined with weaker economic activity and financial turbulence. Draghi (2008) emphasises this in the following: “it is precisely in these difficult situations that the benefits of a sound monetary framework become apparent. Only by ensuring a return to price stability in a reasonable time frame we will be able to control inflation expectations, reduce uncertainty and risk premia, sustain longer-term financing and purchasing power and thus reinforce the prospects for real activity and financial stability” (Draghi (2008), p. 10). The results in Chapter 7 show that one instrument may be sufficient to make central bank policy effective in anchoring inflation expectations, controlling inflation and, given substantial information on risks to financial stability, it induces the financial sector to impose prudence on itself. One may therefore conjecture that central banking practice in accordance with this analysis proposing the benefits of clear announcements (as shown in Chapter 8) and rule-based policy (as shown in Chapter 7) may facilitate the transitional period as mentioned above. A main insight highlighted in this analysis and verified by current events is that the strategic interaction between the central bank and the financial sector needs to be taken into account when designing optimal monetary policy. Nevertheless, further research is needed extending our work to incorporate the effectiveness of a second instrument used for monetary policy. The latter may, for example, incorporate appropriate definitions of capital adequacy or liquidity ratios (affecting the financial stabilisation objective of the central bank as proposed in our analysis).

Thus, as the crisis unfolds policies are taking a variety of shapes that can be grouped within two broad categories: emergency and structural responses. Until now, the first remained typically national since each crisis was unique to the financial structure of the country and so were the remedies. However, as Draghi (2008) remarks: “If the crisis were to become systemic – and beginning of September 2008 has shown just how sudden and dramatic the turn of events can be – it is believed that an internationally coordinated effort will be necessary" (Draghi (2008), p. 2). He further comments that "if the market turbulence tells us anything, it is that the pace of financial innovation in recent years, the volume of transaction in certain markets, the amount of embedded leverage in the system, and the global nature of finance, have transformed the functioning of the international financial system, … [and] these transformations were not fully appreciated in their implications for monetary policy making" (Draghi (2008), p. 8).

Ferguson (2004) remarks that monetary policy has been used to counter financial instability when the latter has been great enough for the financial markets to intermediate effectively. At times when the economic outlook is revised down sharply reflecting large the downside risks, the functioning of the financial markets becomes a clear focus for policymakers (Ferguson (2004), p. 4). Ferguson (2004) stresses before the crisis surfaced that "he cannot leave the subject of supervision without a brief comment on the trend to remove supervision from the responsibility of central banks and to create an overarching single supervisory authority for all financial institutions and markets" adding that "such a structure may well be appropriate for the jurisdictions that have adopted such regulatory frameworks, given their history and institutional development" (Ferguson (2004), p. 5). He certainly respects the decision of countries that have adopted the Financial Supervisory Authority model, and have thus excluded their central banks from the direct supervision and regulation of their banks. However, he believes that such a decision has the potential to undermine a central bank's ability to manage financial crises (Ferguson (2004), p. 5).

Smaghi (2009) remarks that even though "many of the risks that have materialised during the recent crisis had been signalled earlier on, in the public communications by relevant policy authorities, such as the ECB (in its Financial Stability Review and in speeches by Executive Board members), the Bank for International Settlements (in its Quarterly Review of Financial Market Developments and Annual Report), the Bank of England or the International Monetary Fund (in its Global Financial Stability Report), … we can perhaps acknowledge that these communications were not effective in changing the behaviour of financial market participants, nor of the supervisory authorities" (Smaghi (2009), p. 3). This argument points towards the benefits that can be obtained by credible rule-based policy, as the findings of our analysis emphasises.

The institutional framework necessary to support the implementation of macro-prudential supervision mainly involves a central bank and an authority in charge of regulating and supervising financial markets and institutions. The former hosts the analytical capabilities for assessing global financial market developments and macroeconomic risk and the latter is responsible for the stability of individual institutions and has the information on individual participants and market developments. A full flow of information is necessary for a properly functioning system. The supervisory authority provides all the relevant information to the central bank so as to monitor and analyse risk, while the central bank provides information to the micro-prudential supervisor on the results of the risk analysis so as to ensure that appropriate measures are implemented. A distinct allocation of responsibilities and accountability is also vital, according to Smaghi (2009) in order "to ensure that the right incentives are in place for the achievement of results in a cooperative manner rather than inter-institutional fighting, which is a recipe for disaster" (Smaghi (2009), p. 3).

Smaghi (2009) divides the models of monetary policy implications of macro-prudential regulation recommended by the Turner Review into three groups (see Smaghi (2009), p. 4 for a summary). The models developed in our analysis can be considered as variants of Smaghi's Model 2, namely models where "the central bank is not only in charge of identifying risks, but is also able to take specific macro-prudential measures or to require the authority in charge of micro-prudential supervision to do so" (Smaghi (2009), p. 4).

According to our definition of financial stability, the latter requirement is implicit (as it does not necessitate the addition of an extra instrument) but distinctive in our model and incorporated in the shift in the behaviour of both the central bank and (in anticipation) also of the financial sector caused by any changes between the actual and the reference level for financial sector profitability, $P$ and $P^*$. This reference level is determined by several factors of the economy as a whole and may, for example, account for the profitability of the financial sector under full employment, but which cannot be captured in this analysis and needs further research. However, in an effort to make our definition of the financial stabilization objective operational we may consider a simple computation of $P^*$ as discussed in Chapter 7.

As in equation (7.8) the financial sector's profitability $P$ is measured as, $P = 2R - i_0 - i$ . For example, the nominal short-term interest rate directly influenced by the monetary policy, $i_0$, can be represented by the 3-month money-market yield, while a proxy for the long-term nominal interest rate, $R$, can be the 30-year bond yield. As an example, using daily data from the US for a time period between 1.1.2000 to 18.8.2009 (data provided by the Financial Times database), we may compute average values of the parameters in (7.8) in order to use average $P$ as a proxy for $P^*$. The level derived is approximately equal to 4 percent, which can be a useful guide for pre-emptive monetary policy. Nevertheless, further empirical research on the proposed definition is certainly necessary taking account of several related issues as, for example, the fact that interest rate series are cointegrated, as well as the effect changes in $i$ may have on the aggregate value of the assets of differing maturities held by the financial sector, in particular the effect on expected future short rates.

As Smaghi (2009) points out, the de Larosière Report (2009) instead proposes Model 1, according to which "the central bank identifies systemic risks and makes recommendations to the authority in charge of micro-prudential supervision, which sets out the main actions to be taken to address these risks" (Smaghi (2009), p. 4). It suggests the creation of a European Systemic Risk Council (ESRC), embedded in the ECB and corresponding to the General Council that will make recommendations aimed at identifying and correcting systemic vulnerabilities. The responsibility of implementation will remain to national supervisors (Smaghi (2009), p. 5).

In sum, Smaghi (2009) argues that there seem to be greater conflicts of interest between the objectives of micro and macro prudential supervision than between price stability and macro-prudential supervision. He further remarks: “this is the reason why I tend to consider that Model 2, in which the central bank is given two instruments in order to achieve two distinct objectives is more appropriate, especially within the European framework, and even more so for the euro area; this seems to be the model that will be implemented in the US” (Smaghi (2009), p.5). In particular, he reports that “the US administration has proposed to give the Fed powers to address the build up of risks that threaten the financial system as a whole, with a focus on core institutions and markets; the creation of a Council of regulators has been proposed, but the Fed will not need to seek the council’s approval to act against systemic risks” (Smaghi (2009), p. 5).

Draghi (2009) in his remarks on the Turner review rollout on the 27th March 2009 applauds the proposals for enhancing macroprudential analysis, assessing the implications of macroeconomic trends for financial stability. He stresses that “indeed, it is precisely in this area that we have the most to learn from the experience of this crisis, [and] we need to think hard and carefully about how to put these lessons into practice in formulating policies that incorporate financial stability concerns into traditional macroeconomic policy levers as well as regulatory rules and approaches” (Draghi (2009), p. 2).

In addition, Mishkin (2009) states that “an important lesson from the current crisis is that we desperately need a systemic regulator and the Fed is the only logical choice” (Mishkin (2009), p. 2). Nevertheless, he briefly outlines three dangers that such a shift in policy may incorporate, in that, “first, *additional* [emphasis not in the original] objectives may blur the clear focus on achieving output and price stability”, second, the potentially increased political pressure on the Fed could “subject it to attacks on its independence”, and, third, the lack of resources necessary for a central bank (the Federal Reserve in this case) in order to assume the additional role of (macroprudential) systemic regulator. However, Mishkin (2009) makes the following remarks: “Despite these dangers, given the importance of the financial stability goal and the fact that some institution must play the role of the systemic regulator, I strongly believe that the Fed should take on this new task in spite of the difficulties this will pose. Some safeguards can mitigate the difficulties. For example, some central banks have used explicit, numerical long-run inflation objectives to keep the price stability goal firmly in view. As I have argued before on this page, the Fed should head in this direction. Congress also needs to support the Fed’s independence and funding” (Mishkin (2009), p. 2).

The Turner Review published in March 2009 states: “Indeed, it is important to note that not only was there a failure to identify hugely increased risks, but a widely held and authoritatively asserted conventional wisdom that the financial system had become more stable, and the amplitude of economic cycles less pronounced, precisely because of the financial market developments which we now believe led to crisis” (FSA (2009), p. 85). It gives as an example the following statement from the IMF Global Financial Stability Review (GFSR) of April 2006: “There is growing recognition that the dispersion of credit risk by banks to a broader and more diverse group of investors, rather than warehousing such risk on their balance sheets, has helped make the banking and overall financial system more resilient. The improved resilience may be seen in fewer bank failures and more consistent credit provision. Consequently the commercial banks may be less vulnerable today to creditor economic shocks" [quoted from FSA (2009), p. 86]. Nevertheless, it is also stressed that "intellectual challenge to conventional wisdoms is therefore essential, but so too is freedom from political pressure" (FSA (2009), p. 86).

On the above issue of the adverse effect the political context can impose, we contend that our analysis shows that the political context can on the contrary prove beneficial if the latter possibly undertakes the difficult task of enabling the central bank's communication of a potential monetary policy shift from the achievement of a macroeconomic objective towards a financial stabilisation objective and the establishment of rule-based policy. Former US Fedreral Reserve Chairman Volcker's appointment in 1979 can be an example of a helpful political action. Central bank independence seems to be in jeopardy through the events since August 2007. In March 2008 with the rescue of Bear Stearns hopes were high of an imminent establishment of financial stability; however, the events in September 2008 and onwards dashed these hopes. Central bank independence as it has emerged during the period of the 'Great Moderation' refers to the fact that central banks' control over inflation can at times be exercised with some flexibility in order to 'lean against the wind' of imminent recession (see, for example, Mervyn King's complaints Sunday Telegraph 30 May 2009). However, the results in Chapters 7 and 8 bring forward the widely accepted merits of commitment to a rule. In particular, they highlight the merits of a central bank's pre-emptive intervention in the financial system while committed to a monetary policy rule that accounts for financial stability. Our results reinforce the argument for preserving central bank independence not only over the control of inflation but also over the soundness of the financial system. Further research is, nevertheless, necessary on this issue, as well as on the appropriate design of rules in the same way that the Taylor rule emerged from the literature stemming from the Kydland-Prescott and Barro-Gordon paradigm.

Finally, we contend that further extending the extended model in Chapter 7 (subsection 7.6) to introduce the effect of debt default on the financial sector’s profitability over a number of periods may produce useful results in the debate over the timely identification of bubbles and its effect on monetary policy making. Extending this model over time and taking account of the expectations formed about potential levels of default may add to our analysis a comprehensive representation of boom and bust cycles. Further theoretical and empirical work is necessary on this issue.

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