THE INTERACTION BETWEEN EXCHANGE RATES AND STOCK PRICES

by

WEI MAO

A thesis submitted to the

University of Birmingham

for the degree of

DOCTOR OF PHILOSOPHY

Department of Accounting and Finance

Birmingham Business School

University of Birmingham

September 2013

ABSTRACT

This doctoral thesis aims to contribute to the interaction between exchange rates and stock prices at firm level, using a large unbalanced panel consisting UK non-financial companies over the period 1990—2011. There are six chapters. After the Introduction, Chapter 2 critically and comprehensively reviews previous theoretical and empirical studies of the relationship between exchange rates and stock prices, and then suggests several new research ideas. Chapter 3 derived a theoretical framework for the transmission channels through which changes in exchange rates pass-through into stock prices. The model is then calibrated to provide implications. Two main transmission channels are identified: the revenue-side channel and the cost side channel. The findings show that the effect through the revenue-side channel can explain more than 85% of currency exposures, while less than 15% can be explained by impact through the cost-side. Chapter 4 develops an empirical model to provide evidence for the theoretical framework in Chapter 3. Overall, there is significant evidence for the implications in Chapter 3. Meanwhile, this chapter also examines how firms' characteristics have an impact on identified transmission mechanism. Chapter 5 distinguishes the unanticipated parts of exchange rate variations from the anticipated ones, using more advanced return decomposition techniques and VAR specifications. To be specific, foreign exchange beta is decomposed into foreign exchange beta due to unanticipated changes in cash flows and discounted rates. The key findings, contributions and limitations are given in Chapter 6, as well as new research ideas for the future.

To my dear parents

for all your love and support

ACKNOWLEDGEMENTS

I would like to thank many individuals and organizations. Without their support and assistance, this thesis could not have been written.

My greatest and most sincere gratitude is to Professor Victor Murinde and Dr. Ping Wang, my supervisor and co-supervisor. I have very much appreciated their excellent guidance, valuable suggestions and continuous support during my whole PhD programme. They have provided me with outstanding and helpful advice on the research idea and its method and presentation, as well as on career development in the academic area.

I also wish to give my sincere thanks to the Birmingham Business School and the Graduate School of the University of Birmingham for providing financial support for me to present my research papers at the Universitas 21 Doctoral Research Conference in Business (DRCB) in Hartford, USA; at the 10th INFINITI Conference on International Finance in Dublin, Ireland; and at the 20th Global Finance Conference in Monterey, USA.

My sincere gratitude is extended to the speakers and participants at the Universitas 21 Doctoral Research Conference in Business (DRCB), the 10th INFINITI Conference, the 20th Global Finance Conference, the University Graduate School Researcher Poster Conference, the Birmingham Doctoral Symposium and at the research seminar held in the Birmingham Business School, for their valuable suggestions and critical comments on previous versions of the chapters in this thesis.

I am also indebted to all the staff and my fellow PhD students in the Corporate Finance Research Group in the Birmingham Business School, who helped me, encouraged me and made my stay in the UK a very enjoyable one.

I would like to extend my gratitude to Nick Turner, my third editor, who gives me very useful suggestions on the spelling and grammar.

Finally, and most importantly, my deepest gratitude is to my dearest parents, Yujian Mao and Chenxia Wang. Without their unconditional support, deep love, continuous encouragement and patience, this research could not have been carried out.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDINCES

CHAPTER 1

INTRODUCTION

1.1 Motivation

The interaction between exchange rates and stock prices has attracted a great deal of research interests for more than thirty years (See, for example, Jorion, 1990; Jorion, 1991; Bartov & Bodnar, 1994; Choi & Prasad, 1995; Chow, Lee & Solt, 1997; Abdalla & Murinde, 1997, He & Ng, 1998; Granger, et al. 2000; Nieh & Lee, 2001; Fang and Miller, 2002; Smyth & Nandha, 2003, Hatemi-J & Irandoust, 2005; Pan, Fok & Liu, 2007; among many others). Recently, the global stock market and the foreign exchange market have been affected by the worldwide financial crisis, and therefore the relationship between these two major financial markets now attracts even more attention (See, for example, Alagidedea, Panagiotidi & Zhang, 2011; Ehrmann Fratzscher & Rigobon, 2011, Katechos, 2011, Bartram & Bodnar, 2012; Lin, 2012; Chen & Chen, 2012; Jongen, Muller & Verschoor, 2012; Lee & Suh, 2012; Pan & Liu, 2012; Chaieb & Mazzotta, 2013; among others). After the housing bubble collapsed in the US in 2006, global stock prices saw a large drop in 2008 and 2009, due to a decline in credit availability and damaged investor confidence. At the same time, unusual movements in exchange rates have been detected. Kohler (2010) found that the recent financial crisis is different from the Asian financial crisis in the following ways. Firstly, all the selected currencies, including AUD, CAD, NZD, NOK, SEK, BRL, CLP, RUB, ZAR, depreciated sharply against the US dollar, while this also happened to Asian currencies during the 1997 crisis. Little change was found in small advanced countries not at the centre of the crises. , except for Australia and New Zealand, whose dollars reacted to the Asian crisis. (Kohler, 2010) Furthermore, there is a relatively strong and quick reversal of the depreciation compared to the Asian crisis (Kohler, 2010). Therefore, motivated by this global financial crisis, it is both necessary and interesting to review the interaction between exchange rates and stock prices in the new era.

Although much effort has been devoted to the relationship between exchange rates and stock prices, the main focus of previous studies has been on Granger causality between these two markets at macro-level, and foreign exchange rate exposure at firm-level. Financial theory suggests that foreign exchange risk should be priced in the stock prices due to its effect on firms' earnings. At the same time, it is also suggests that stock prices should be employed to explain and predict foreign exchange rates, following the portfolio approach. However, at micro level, most recent studies argue that causality runs predominantly from exchange rates to stock prices (see, for example, Carrieri et al, 2006; Bartram, 2007; Kolari et al, 2008; Chue and Cook, 2008; Choi & Jiang, 2009, Aggarwal & Harper, 2010; among others). The reasons are as follows: On one hand, multinationals are significantly affected by foreign exchange risk due to transaction exposure, economic exposure, translation exposure and exposure to imported substitutes (Choi & Prasad, 1995; Choi, et al., 1998; Allayannis & Ihrig, 2001; Ahmed, Omneya & Amr, 2007; Kolari et al, 2008; Jongen, Muller & Verschoor, 2012; Chaieb & Mazzotta, 2013; among others). In particular, the consolidated financial statement for a firm with subsidiaries located in foreign countries will naturally be affected by the changes in foreign exchange rates. Furthermore, if a firm with outstanding obligations denominated in foreign currency, this will be affected by foreign exchange rates as well. More importantly, decreases in exchange rates make the selling prices denominated in foreign currency cheaper and thus affecting firms' future cash flows and their stock prices. Even for domestic companies, foreign exchange rate fluctuations will affect their value through import inputs and competition. (See, for example, Bodnar et al., 2003; Choi & Jiang, 2009, Aggarwal & Harper, 2010; Hutson & Stevenson, 2010 among many others). Take cosmetics industry for example. If sterling is appreciated against Euro, the UK selling price for skin cream made in German will become cheaper and thus increasing its sales. As a result, stock prices of UK cosmetics companies will decrease as a result of declining sales and future cash flows. On the other hand, changes in a firm's stock price are too tiny to lead the fluctuation in foreign exchange rates. Therefore, at micro level, it is assumed that causality runs predominantly from exchange rates to stock prices.

Some researchers argue that falling exchange rates may simply be the manifestation of a poorly performing economy, and there is no direct relation between exchange rates and stock prices. However, this is not true. The effect of exchange rates on a firm's cash flow denominated in home currency is primarily a function of the elasticity of the demand for the firm's product to exchange rates. Take an export company for example. Home currency depreciation will lead to a decreased export selling price denominated in foreign currency and thus an increase in demand for the firm's product aboard. If the price elasticity is low (less than one), the increased demand will not be able to compensate the profit loss due to the declined prices, and therefore decreasing the firm's cash flows and equity price. However, if the price elasticity is high (greater than one), the demand for the firm's product will significantly increase, and lead the cash flows and stock price to grow. Therefore, falling exchange rates do affect stock prices. However, there is as yet no study to show the transmission mechanisms through which changes in exchange rates pass-through into stock prices. In other words, although there is abundant research discussing the impact of exchange rates on stock prices, little is known about how and why this effect occurs.

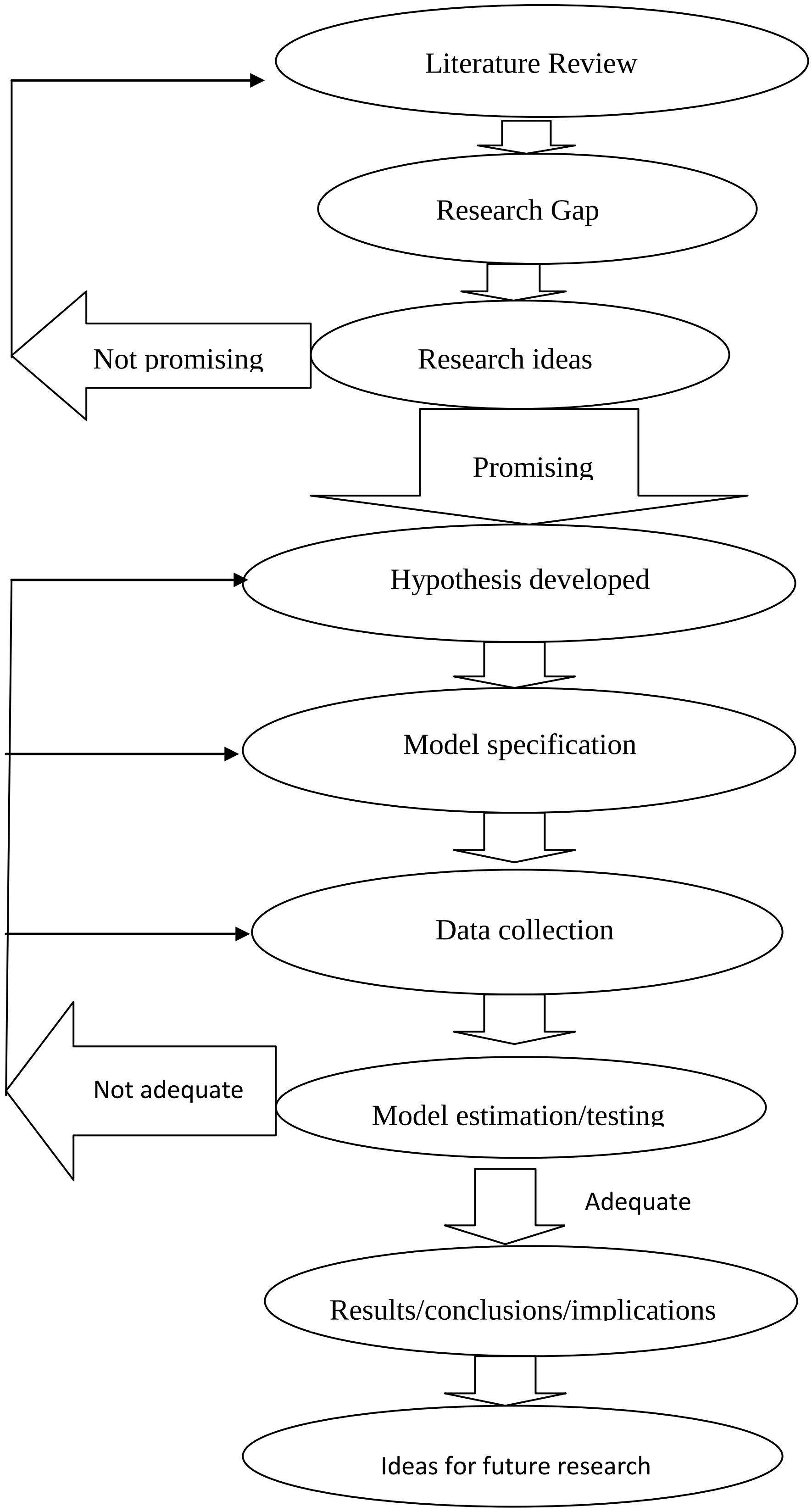
Previous research on the transmission mechanisms through which changes in exchange rates pass-through into other economic variables, such as CPI, employment and wages, provides a reasonable methodology for this issue (See, for example, Campa and Goldberg, 2001; Goldberg and Campa, 2010; Nucci & Pozzolo, 2010; among others). Therefore, partial differentiation of equity prices with regard to exchange rates can be employed, so that our understanding of the effect of exchange rate fluctuations on stock prices will be greatly improved. It is worth highlighting that, by tracing and quantifying the transmission channels through which changes in exchange rates pass-through into stock prices, an answer to the question of how and why firms' value is exposed to foreign exchange rate risk will be given.

Although transmission channels have been identified in theoretical frameworks in Chapter 3, there is no empirical evidence to show their application in the real world. Given the importance of empirical research to theoretical development, it is necessary to examine this transmission mechanism from an empirical perspective. If the results demonstrate currency exposure through changes in identified channels, we will see how stock prices are affected by foreign exchange risk. Existing research also provides additional evidence on the determinants of foreign exchange rate exposure. However, there is a lack of studies investigating how these determinants work. To address this gap and offer consistent and comparative findings, the impact of firm characteristics on the identified transmission channels will be studied. Therefore, we can obtain a clear understanding of why different types of firm face various foreign exchange rate exposures.

Recently, research has questioned the use of anticipated changes in exchange rates when examining currency exposure. Financial theory suggests that expected changes should have little effect on assets, and should already be priced into them (Bredin & Hyde, 2011). It is inappropriate to employ “realized” changes in exchange rates as a proxy for unexpected ones. It is, therefore, more useful to distinguish the unanticipated parts of exchange rate variations from the anticipated parts, and to decompose the unanticipated currency exposure. Recent developments in return decomposition and empirical VAR specification make this possible. This thesis, therefore, will extend foreign exchange exposure research by modelling firm-level unanticipated currency exposure, in an attempt to provide new and more accurate evidence of the interaction between exchange rates and stock prices at micro level.

1.2 Data and methodology

Figure 1.1 Flowchart for the methodology in this thesis



The methodology employed in this thesis is shown in Figure 1.1 as a simple flowchart. We begin with a comprehensive and critical review of research on the relationship between exchange rates and stock prices. Next, the research gaps and some new research ideas are identified. If the idea is promising, we then develop the hypothesis and model specification. If not, we return to the literature review and modify our research ideas. After the model and hypothesis have been thoroughly developed, data is collected for estimation and hypothesis testing. If the results are statistically significant with regard to expected sign and magnitude, conclusions and implications can be drawn, as well as promising research ideas for the future. Otherwise, we go back step by step to check the effectiveness of our method.

The data employed in this thesis is mainly secondary data from various sources. Firm-specific data such as accounting data for UK-listed non-financial companies over a period between 1990 and 2011 is retrieved from the Worldscope database via Thomas One Banker Analytics. The reason why the Worldscope database is employed is that it provides some of the most comprehensive accounting and financial data for firms, from a large number of exchanges. Monthly stock price data for the same range of firms over the same period is collected from the Datastream database. Trade-weighted exchange rate data for sterling is obtained from the official website of the Bank of England.

In the first stage of data collecting, all data from the financial statements of all UK non-financial firms over a period between 1980 and 2011 has been obtained, as well as stock prices and exchange rates, in order to avoid adding extra data at a later stage. Due to the nature of the research question, and to model specifications and the estimation technique in each chapter, the size of the sample is restricted. The detailed procedure used for its construction is presented in each chapter.

The UK is chosen for analysis for the following reasons. Firstly, research on foreign exchange rate exposure mainly covers the US market (See, for example, Jorion, 1990; Jorion, 1991; Bartov & Bodnar, 1994; Choi & Prasad, 1995; Chow, Lee & Solt, 1997; Gao, 2000; Allayannis & Ihrig, 2001; Muller & Verschoor, 2006a; Muller & Verschoor, 2006b; Priestley & Ødegaard, 2007; Kolari et al, 2008; Jongen, Muller & Verschoor, 2012; Lee & Suh, 2012; Pan & Liu, 2012; Chaieb & Mazzotta, 2013; among many others). However, there is little evidence for the UK market. More importantly, UK sterling has experienced a much larger fall during this crisis, than the euro or other currencies. Therefore, investigating the interaction between exchange rates and stock prices in the UK market will add new evidence to existing research.

Finally, our sample is restricted to a large unbalanced panel of data consisting of firm-year observations. The unbalanced data can keep supervisor bias problems away.

More importantly, panel data can benefit from the rich information contained in both time-series and cross-sectional observations.

The empirical models in this thesis are estimated using a number of techniques for panel data including system GMM, fix-effect and pooled OLS estimators. The model specification determines which estimator is employed. In addition, diagnostics tests and robustness checks are carried out to examine the effectiveness of the estimation results. Each chapter, excluding chapter 1 and 6, is structured this way, as shown in Figure 1.1.

1.3 Structure of the thesis

This thesis contains six chapters overall, including an introduction, a comprehensive literature review chapter, a theory extension and calibration chapter, two empirical chapters and a conclusion.

Chapter 2 is the literature review. Here, both theoretical and empirical studies of the interaction between exchange rates and stock prices are critically and comprehensively reviewed. In particular, this section looks at Granger causality between these two markets at macro level, and then studies foreign exchange exposure literature at micro level. In addition, share valuation models and stock return decomposition are also examined, in order to provide an advanced methodology for this issue. Finally, several research gaps and new research ideas are proposed.

Chapter 3 presents the theoretical framework for the first new idea. After a definition of exchange rate exposure, we take the partial differentiation of the share value equation with regard to exchange rates, in order to identify the transmission channels through which changes in exchange rates pass-through into stock prices. Furthermore, data from UK non-financial firms is employed to calibrate the model and to provide useful results. They show that changes in foreign exchange rate affect equity prices through two channels: cost-side channel and revenue-side channel. Moreover, the effect through the revenue-side channel can explain more than 85% of currency exposure, while less than 15% can be explained by impact through cost-side.

Chapter 4 provides an empirical specification based on the implications of Chapter 3, thus giving empirical evidence for it. In general, this part supports the findings in Chapter 3, as indicated by the significant coefficient associated with the channel effect. Moreover, it is suggested here that the permanent “bad” effect outweighs the transitory “good” effect. In other words, foreign exchange exposure via revenue-side channel on average dominates the effect via cost of capital channel, so that future investment opportunities are reduced. In addition, Chapter 4 also makes an attempt to examine the impact of firm characteristics on these transmission channels. Firms' size and foreign sales ratio are suggested to be positively related to effects through earnings channel and net elasticity, while there is a negative relationship to leverage ratio.

Chapter 5 presents the last empirical paper in this thesis. It extends the research to investigate sources of unanticipated exchange rate exposure. It employs the stock return decomposition framework and an empirical VAR specification to decompose foreign exchange beta into two components, cash flow and discounted rate, using a large unbalanced panel of UK-listed non-financial firms for the period 1990-2011. This shows that variance in cash flows is the main driver of total variance in stock prices. It is important to note that foreign exchange exposure via the discounted rate channel on average outweighs the effect via the cash flow channel during 1990-2011. However, the cash flow channel is used as the main channel for variations in exchange rate pass-through into stock prices during 1990-2008. This implies that the effect of the discounted rate channel increases dramatically during financial crises. In normal periods, however, it is consistent with the implications of our theoretical framework.

Chapter 6 concludes. The main findings are summarized, followed by the chief contributions and practical implications overall. In addition, this chapter also discusses the limitations of our investigation, as well as offering promising ideas for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The interaction between exchange rates and stock prices attracts a large amount of research interest as a result of today's dramatic increases in world trade and capital movement. (see, for example, Alagidedea, Panagiotidi & Zhang, 2011; Ehrmann Fratzscher & Rigobon, 2011, Katechos, 2011, Bartram & Bodnar, 2012; Lin, 2012; Chen & Chen, 2012; Jongen, Muller & Verschoor, 2012; Lee & Suh, 2012; Pan & Liu, 2012; Chaieb & Mazzotta, 2013; among many others) This globalization, as well as financial liberation, means that currency is one of the main determinants of business profitability and share prices. Therefore, the link between these two markets is the subject of much debate.

One of the debates relates to macro-level relations. In particular, the Granger causality between exchange rates and stock prices, in particular, is the main research question at macro level. Theoretical framework suggests two approaches to the link between these two markets: a traditional approach and a portfolio approach. The traditional approach is based on the "flow-oriented" exchange rate models, therefore suggesting a Granger causality running from exchange rates to stock prices. On the other hand, the portfolio approach is on the basis of "stock- oriented" exchange rate models, thus indicating that the effect is from stock prices to exchange rates. Empirical evidence has found four types of relations in various financial markets: bi-directional relations, unidirectional relation from stock prices to exchange rates, unidirectional relation from exchange rates to stock prices, and no relation. Although there is no consensus on either theoretical or empirical evidence on the interaction between exchange rates and stock prices at macro level, research generally confirms that these two markets should be linked together, especially during a crisis period.

Another popular topic in the relationship between exchange rates and stock prices is foreign exchange rate exposure in research. This refers to the relationship between these two markets at micro level. In particular, at micro level, Granger causality is predetermined, running from exchange rates to stock prices. Changes in exchange rate will have an impact on selling prices and liabilities denominated in foreign currencies, sales, imported inputs and competing environments, thus affecting final share prices. We focus our study in this thesis on the relationship between these two markets at micro level. Research has defined the sensitivity of assets' value to changes in foreign exchange rates as "exchange rate exposure". Therefore, reviewing the valuation method for equity price is necessary for exchange rate exposure analysis. Three empirical models, the Discounted Dividend model, the Free cash Flow model and Residual Income model receive most attention in literature. In particular, researchers attempt to assess the performance of each model in actual stock prices and also compare their application with empirical studies. Generally, research suggests that the Residual Income model is greatly superior to the other two.

At firm-level, early empirical studies focus on whether foreign exchange risk is priced in stock prices, and if so, how significantly. In addition, the effect of firm characteristics on this impact is also examined. Unfortunately, empirical studies prove that significant evidence of foreign exchange rate exposure is relatively low. (See, for example, Jorion, 1990; Jorion, 1991; Bartov & Bodnar, 1994; Choi & Prasad, 1995; Chow, Lee & Solt, 1997; He & Ng, 1998; Jongen, Muller & Verschoor, 2012; Lee & Suh, 2012; Pan & Liu, 2012; Chaieb & Mazzotta, 2013; among many others). Many studies attribute this puzzle to either modelling issues or hedging activities. More recently, researchers have focused their interest on the economic rather than the statistical significance. For example, Bartram & Bodnar (2012) claimed that although many exposures are not statistically significant and noisy, currency exposure estimates are economically meaningful in terms of return generation of stock prices variation. Therefore, investigating foreign exchange exposure is important for risk managers, policy makers and researchers. In addition, the foreign exchange rate exposure puzzle might be explained by examining how and why exchange rates have an impact on stock prices.

Over the last two years, researchers have recognized the poor measurement of changes in exchange rates. Financial theory suggests that only unanticipated changes in exchange rates should affect stock prices, since the expected changes have already been priced. Stock return decomposition development has attracted a great deal of attention. Therefore, it might be possible to employ the new methodology of variance decomposition to study the impact of unanticipated changes on stock prices. For example, Bredin & Hyde (2011) employed a first-order VAR including three state variables (real stock market excess return, exchange rate changes and interest rate changes) to study unanticipated foreign exchange exposure.

The reminder of this chapter is organised as follows. Section 2.2 reviews the interaction between exchange rates and stock prices at macro level, both theoretically and empirically. The micro linkage between these two markets is given in Section 2.3, including modelling issues as well as the main empirical findings. Section 2.4 examines share valuation approaches in studies in accounting, in addition to empirical applications of these valuation models. Section 2.5 focuses on return decomposition literature and the effect of unanticipated changes on stock prices. Concluding remarks and innovative research ideas are given in Section 2.6.

2.2 Interaction between stock prices and exchange rates--macro level

This section reviews the interaction between exchange rates and stock prices at macro level. At macro level, the main research enquiry relates to short-term and long-term relations between aggregate stock prices and the value of exchange rates. Cointegration techniques are always employed here to investigate whether long-term interactions between the stock market and foreign exchange market exist. Researchers are also interested in examining the short-term Granger causality on these two markets. Studies suggest that Granger causality can be divided into four catalogues: bi-directional relations, unidirectional relation from stock prices to exchange rates, unidirectional relation from exchange rates to stock prices, and no relation. In this section, we will both theoretically and empirically review these two main lines of enquiry related to the interaction between stock prices and exchange rates.

2.2.1 Theoretical evidence

From a theoretical aspect, there are two main approaches to the interaction between exchange rates and stock prices in research, a "traditional approach" and a "portfolio approach". The traditional approach is usually related to "flow-oriented" exchange rate models, which are based on the interest-parity condition and goods market hypothesis. Flow-oriented exchange rate models were firstly proposed by Dornbush and Fisher (1980). They assume that exchange rates are determined by a country's current account and trade balance performance (Dornbush and Fisher 1980). Advocates of these models argue that the Granger causality of exchange rates and stock prices is running from the former to the latter. In specific, it is suggested that stock prices are affected by exchange rates in the following ways. Firstly, changes in exchange rates will have an impact on international competitiveness, and then on actual income. Since stock price can be viewed as the present value of a firm's future cash flows of the firm, it will be affected by exchange rates. For example, currency depreciation makes exporting goods cheaper for foreign countries, therefore increasing foreign demand and sales, as well as the value of a firm that exports. Moreover, due to transaction exposure, future payables or receivables denominated in foreign currency can also be influenced by changes in exchange rates. Even with domestic firms, imported inputs, output prices or product demand are affected by variations in foreign exchange rates. In conclusion, there is a solid theoretical basis for Granger causality running from exchange rates to stock prices.

On the other hand, based on "stock-oriented" exchange rate models, research suggests that exchange rates can also be affected by stock prices. This portfolio approach assumes that exchange rates equate the supply and demand of assets. As opposed to"flow-oriented" exchange rate models, "stock-oriented" models view capital account as the major determinant of exchange rates. Branson (1983) and Gavin (1989) argue that innovations in the stock market would have an impact on wealth and liquidity, thus influencing money demand and exchange rates. For example, a blossoming stock market causes an increase in the wealth of domestic investors, which leads to a higher money demand and higher interest rates. Subsequently, higher interest rates encourage capital inflows and then currency appreciation. However, when the financial crisis began, people lost confidence in economic and political stability, and thus shifted their portfolio preference from domestic assets to other assets denominated in foreign currencies. This shift in preference will lead in turn to a decrease in the demand of money, therefore resulting in capital outflows with currency depreciation. In conclusion, the portfolio approach advocates that the stock prices Granger causes the changes in exchange rates. In addition to this portfolio balance model, there is another type of model based on “stock-oriented” exchange rate models, namely the monetary model. Gavin (1989) suggests that both exchange rates and stock prices are influenced by a number of common factors. Therefore, there is no linkage between exchange rates and stock prices.

In summary, the theoretical framework indicates that Granger causality can run either from exchange rates to stock prices or from stock prices to exchange rates. There is no consensus on the relationship between exchange rates and stock prices from a theoretical aspect.

2.2.2 Empirical evidence

After studying the theoretical backgrounds to interaction between exchange rates and stock prices, this section will carefully review the empirical evidence, in order to provide its own empirical evidence of each approach in the real economy. In the empirical studies, Granger causality is usually tested based on the following BVAR (Bivariate vector autoregression):

$$EX_t = \sum_{j=1}^{m} \alpha_j EX_{t-j} + \sum_{j=1}^{n} \beta_j SP_{t-j} + \varepsilon_t \quad (2.1)$$

$$SP_t = \sum_{j=1}^{m} c_j EX_{t-j} + \sum_{j=1}^{n} d_j SP_{t-j} + \mu_t \quad (2.2)$$

Where EX is the exchange rate variable; SP is the stock price variable; ε_t and μ_t are the error terms, which are assumed to be serially uncorrelated with zero mean and finite covariance matrix. The four definitions of Granger causality can be obtained as follows: (1) For SP to Granger-cause EX, the coefficient $\beta_j \neq 0$ in equation (2.1), whereas $c_j = 0$ in equation (2.2); (2) For EX to Granger-cause SP, the coefficient$c_j \neq 0$, whereas$\beta_j = 0$; (3) For feedback causality between EX and SP, the coefficient$c_j \neq 0$, whereas$\beta_j \neq 0$; (4) For independence between EX and SP, the coefficient$c_j = 0$, whereas$\beta_j = 0$. Based on this definition, mixed results between exchange rates and stock prices have been found in the empirical studies.

2.2.2.1 Unidirectional causality from exchange rates to stock prices

On one hand, there is abundant empirical evidence regarding the traditional approach, which suggests that changes in exchange rate should lead stock price movements. (See, for example, Soenen & Hennigar, 1988; Abdalla & Murinde, 1997; Nieh & Lee, 2001; Granger, et al. 2000; Fang & Miller, 2002; Smyt & Nandha, 2003; Pan, Fok & Liu, 2007; Alagidedea, Panagiotidi & Zhang, 2011; Ehrmann Fratzscher & Rigobon, 2011; Chen & Chen, 2012; among many others). Soenen & Hennigar (1988) were among the first to study the impact of exchange rates on stock prices. They employed monthly US stock prices and dollar exchange rates between 1980 and 1986, and found a strong negative relationship between stock prices and exchange rates. In addition, this result cannot be changed by a strong or weak dollar. In the 1990s, rapid developments in econometrics including unit root tests, cointegration and Granger causality tests encouraged many researchers to examine this issue using newly developed techniques. Some academics have studied the relationship between exchange rates and stock prices in developed countries. For example, Nieh & Lee (2001) examined the dynamic relations between exchange rates and stock prices for the G-7 countries (Canada, France, Germany, Italy, Japan, UK and the US) using daily data taken from 01/10/1993 to 15/02/1996. They found that short-term causality running from exchange rates to stock prices is only significant for one day in Germany, Canada and the UK. To be specific, the German financial market will be stimulated by currency appreciation while it decreases stock returns in Canada and the UK.

Abdalla & Murinde (1997) firstly examine this dynamic in emerging financial markets. Due to data availability, monthly data from India, Korea, Pakistan and the Philippines from 01/1985 to 07/1994 is used. It revealed that causality linkage between exchange rates and stock prices follows the traditional approach in India, Korea and Pakistan. In other words, changes in exchange rates determine stock return movements in India, Korea and Pakistan. Murinde & Poshakwale (2004) studied Granger causality between these two markets again in European emerging countries before and after the Euro period, using daily observations for two periods: 2/1/1995 – 31/12/1998 and 1/1/1999 – 31/12/2003. The results show that Granger causality running from exchange rates to stock prices is found in Hungary, the Czech Republic and Poland during the Euro period. Following the work of Abdalla & Murinde (1997), there are a number of studies investigating causality linkage between exchange rates and stock prices in developing countries. For example, Wongbangpo & Sharma (2002) examine the dynamic relations between the stock market and key macroeconomic variables such as money supply, interest rate, exchange rate and other variables, for five Asian countries - Indonesia, Malaysia, Thailand, Singapore and the Philippines - using monthly observations between 1985 and 1996. In terms of Granger causality between stock prices and exchange rates, it is suggested that it in the short run it will be exchange rates that affect stock prices in the for Indonesian, Malaysian, and Thai markets. Similarly, Mishra (2005) employed monthly data for a period between 04/1992 and 03/2002 to examine this relationship in India. As well as exchange rates and stock prices in the Vector Auto Regression, interest rate and demand for money are also included so that common economic factors, as suggested by monetary models of exchange rates can be captured. Using forecast error variance decomposition, it is found that exchange rate returns have an impact on stock returns in India, which is consistent with the findings of Abdalla & Murinde (1997).

The Asian financial crisis began in 1997, when the foreign exchange market collapsed as well as the Asian stock market. Not surprisingly, there are an increasing number of studies examining the interaction between exchange rates and stock prices in Asian countries during the crisis. One of the most important is by Granger, Huang & Yang (2000), who were among the first to study the short-term dynamics between exchange rates and stock prices in a number of Asian countries during the Asian flu. The unit root test, cointegration test and Granger test were employed on daily data from 03/01/1986 to 16/06/1998. The results showed that only South Korea followed the traditional approach, meaning that exchange rates cause stock market changes in South Korea. Fang and Miller (2002) also carefully studied the impact of currency depreciation on the stock market in South Korea during the Asian financial crisis. As well as using the unit root test, the cointegration test and the Granger test, as Granger, Huang & Yang (2000) did, they also used the GARCH-M model on daily data from 03/01/1997 to 21/12/2000, to examine the volatility effect. It is suggested that the stock market in South Korea will be significantly affected by exchange rates. More importantly, three distinct channels through which exchange rates affect stock prices are found. Firstly, stock market returns will be influenced by currency changes. Secondly, there is also a positive relationship between stock market returns and exchange rate volatility. Thirdly, exchange rate volatility also causes an increase in stock market volatility. Similarly, Smyt & Nandha (2003) also studied the relationship between exchange rates and stock prices in South Asia using daily data from 1995 to 2001. Their empirical results show that Granger causality in India and Sri Lanka runs from exchange rates to stock prices, which confirm the traditional approach to the interaction between them. Hatemi-J & Roca (2005) also examined this causality immediately before and after the Asian financial crisis (1/1/1997—31/12/1997) for four Asian countries: Malaysia, Indonesia, the Philippines and Thailand. Using bootstrap simulation causality tests with leveraged adjustments, they found that exchange rates Granger cause changes in Indonesian and Thai stock markets only before the Asian crisis. Two years later, Pan, Fok & Liu (2007) again studied this issue in relation to East Asian markets. A causal relationship between exchange rates and stock prices was found for all Asian countries, except Malaysia. Before the 1997 Asian financial crisis, it was suggested that exchange rates in Japan, Malaysia and Thailand should affect stock returns. However, during the crisis, this unidirectional Granger causality, running from exchange rates to stock prices, was found in more countries including Hong Kong, Japan, Korea, Singapore, Taiwan and Thailand. In addition, Yau & Nieh (2006) employed both linear and non-linear methodologies to investigate the interaction between exchange rates and stock prices in Taiwan during the period 01/1991 - 07/ 2005. They suggested that the traditional approach is more significant in the long run, while Taiwan's financial markets follow the portfolio approach in the short term.

Because the interaction between exchange rates and stock prices is so important to researchers, investors and policy makers, there have been a great many studies examining this issue published over the last two years. Alagidedea, Panagiotidi and Zhang (2011) employed recently developed econometric techniques including the Hiemstra-Jones test, Hsiao's version of the Granger causality test, among many others, to study both linear and non-linear causal linkage between stock markets and foreign exchange markets in Australia, Canada, Japan, Switzerland and the UK. Using monthly observations for the period 01/1992 - 12/2005, Granger causality from exchange rates to stock prices is found in Canada, Switzerland and the UK. At the same time, Ehrmann Fratzscher & Rigobon (2011) investigated international financial transmission in stock markets, money markets and exchange rates. By employing a simultaneous equation and the Cholesky decompositions framework, they found that Euro area stock markets are affected by exchange rates. This is in line with the implications of the traditional approach. More recently, Mun (2012) studied the joint response of the foreign exchange market and the stock market to macroeconomic surprises for a long period from 12/1984 to 12/2006. The VAR-CARCH-M model was employed to examine dynamic linkage between countries, as well as their various assets. The results indicate that macroeconomic changes caused by the foreign exchange market can decrease the linkage between Japan, the US stock market and the foreign exchange market. In addition, linear and non-linear causality between exchange rates and stock prices was also investigated by Chen & Chen (2012) last year. A larger sample including 12 OECD countries is included in their research. They found that only the Czech Republic experienced linear causality running from its foreign exchange market to the stock market. When considering non-linear Granger causality, Germany is another example for the traditional approach. The most recent work here is by Tsagkanos & Siriopoulos (2013), who examine this causality during the recent financial crisis (2008-2012). Using both daily and monthly observations, they have found that changes in exchange rates drive stock returns in normal periods for both the EU and the US.

In summary, there is a long list of empirical studies which demonstrate that Granger causality runs unidirectionally from exchange rates to stock prices, and this is consistent with the implications of the traditional approach. Linear or non-linear Granger causality tests cannot change these results.

2.2.2.2 Unidirectional causality from stock prices to exchange rates

On the other hand, there is also a great amount of empirical evidence for the portfolio approach, indicating that there is unidirectional causality from stock prices to exchange rates. (See, for example, Gavin, 1989; Smith, 1992; Nieh & Lee, 2001; Yang & Doong, 2004; Stavarek, 2005; Katechos, 2011; Lin, 2012; among many others) Gavin (1989) firstly developed a theoretical model of a small, open economy to study the dynamic between exchange rates and stock prices. It assumes that the stock market rather than the bond market determines the aggregate demand. In particular, it suggested that the exchange rate implications of shifts in monetary policy can be dampened by interactions between output, profitability, stock prices and aggregate demand. Theoretically, the stock market effect can even be large enough to cause real exchange rate appreciated as a result of expansionary monetary policy. That is to say, the foreign exchange rate market can be significantly affected by the stock market. Smith (1992) was one of the advocates of the portfolio approach in its early years. Smith (1992a) studies the interaction between exchange rates and stock prices in the UK using quarterly data from the first quarter in 1974 to the third quarter in 1988. In the portfolio balance model of exchange rates, he employed equities to drive an estimable exchange rate equation and found that stock prices in the UK can lead the changes in exchange rates between the UK pound and the US dollar. In the same year, he examined this relationship again, theoretically, using a multi-country approach. Smith (1992b) developed a theoretical model of optimal choice over risky assets to produce an estimable exchange rate equation. In contrast to the previous research, the assets include equities as well as government bonds and money. This model was estimated using quarterly data from the period 1974 - 1988. It is found that the value of German mark-U.S. dollar and Japanese yen- U.S. dollar exchange rates are greatly affected by their stock prices.

Early studies found evidence of the portfolio approach in developed countries. Ajayi et al. (1998) employed the error correction model to study short-term and long-term relations between exchange rates and stock prices in eight advanced countries, using daily observations over the period from 04/1985 to 07/1991. The results suggest that aggregate stock price affects exchange rates negatively in Canada, France, Germany, Italy, Japan, the Netherlands, the UK and the US. Nieh & Lee (2001) used daily data from 01/10/1993 to 15/02/1996 to examine exchange rates and stock prices dynamics, and concluded that there is a negative Granger causality running from stock prices to exchange rates in Italy and Japan. This interaction was investigated again with regard to the G-7 countries by Yang & Doong (2004). A multivariate version of Nelson's (1991) Exponential GARCH (EGARCH) model was employed for weekly observations over the period 01/05/1979 - 01/01/1999 to study price and volatility spillovers between exchange rates and stock prices. The results confirm the portfolio approach in both mean return and volatility for France, Italy, Japan, and the US. To be specific, future exchange rates movements are due to stock price changes, and the volatility of the stock market is also significantly transmitted to the exchange rate market. This result is consistent with Hatemi-J & Irandoust (2005)'s study for Sweden. Hatemi-J & Irandoust (2005) used a new non-causality testing procedure to contribute to the debate about the interaction between exchange rates and stock prices. Results show that exchange rate movements are a result of changes in the stock market in Sweden. In the same year, Stavarek (2005) also found Granger causality running from stock prices to exchange rates in the UK, Germany and France, using monthly data from 1969 to 2003. Hau & Rey (2006) developed a new model for stock prices, exchange rates and capital flows determined jointly. This model was then empirically tested with a large number of the17 OECD countries. Using various frequency data including daily, monthly and quarterly observations, the portfolio approach was demonstrated again. In particular, the exchange rate is here found to be determined mainly by investment flows. Hence, higher domestic stock market returns relative to the foreign equity market result in home currency appreciation.

Following studies in advanced economies, the interaction between exchange rates and stock prices was also examined in a number of emerging markets. For example, Abdalla & Murinde (1997) firstly raised the Granger causality enquiry between these two markets in emerging ones, and found that there is unidirectional causality from stock prices to exchange rates in the Philippines. Murinde & Poshakwale (2004) also studied this Granger causality for European emerging markets before and after the Euro period, using daily observations from two periods: 2/1/1995 – 31/12/1998, and 1/1/1999 – 31/12/2003. In the pre-Euro period, there is significant evidence for the portfolio approach in Hungary. Similar results were obtained by Granger et al. (2000). As well as the Philippines, foreign exchange markets in Hong Kong, Malaysia, Singapore, Thailand and Taiwan were also found to be affected by the stock market, as suggested by Granger et al. (2000). Both linear and non-linear relations between exchange rates and stock prices in Taiwan are examined by Yau & Nieh (2006). They found that short-term changes in stock price affect exchange rate movements. The Asian financial crisis also attracts a great deal of interest, with regard to the debate about the interaction between exchange rates and stock prices. For example, Hatemi-J & Roca (2005) studied this issue by using a new bootstrap simulation causality tests with leveraged adjustments. Before the Asian crisis, the exchange rate for Malaysia is found to be affected by its stock market, which is in line with the portfolio approach.

In recent years, exchange rates and stock prices dynamics have been widely researched. For example, Katechos (2011) employed a new exchange rate determination approach named the ML-GARCH [1, 1] model to study the underlying causality between these two markets. Using weekly data over a period 01/1999 - 08/2010, the study found evidence for the unidirectional causality running from stock prices to exchange rates. In the same year, Alagidedea, Panagiotidi and Zhang (2011) confirmed the findings of Katechos (2011), using Hiemstra–Jones non-linear causality tests for Japan. However, this evidence for Switzerland is weak. Similarly, Chen & Chen (2012) study both linear and non-linear Granger causality between exchange rates and stock prices for 12 OECD countries. In terms of linear causality running from stock prices to exchange rates, there is significant evidence for this in the US, Canada, Germany, the UK, Italy and Turkey. However, when non-linear causality is considered, only Poland and Turkey experience the portfolio approach with the interactions between exchange rates and stock prices. Lin (2012) also investigates this relationship in emerging Asian countries. In contrast with previous studies, structure breaks are part of his research of the period between 01/1986 and 12/2010. It is suggested that decreases in the stock market induce capital outflows, therefore putting downward pressure on the currency. Using a large sample of weekly data, the Philippines and Thailand are found to confirm this phenomenon.

In summary, similarly to the findings for unidirectional causality running from exchange rates to stock prices, there is also abundant evidence for the portfolio approach. In other words, empirical results show that stock prices can also drive exchange rates at macro level.

2.2.2.3 Bidirectional relationship between stock prices and exchange rates

In empirical studies, there is also some evidence for both the traditional approach and the portfolio approach, indicating bidirectional interaction between exchange rates and stock prices (See, for example, Bahmani-Oskooee & Sohrabian, 1992; Ajayi & Mougoue, 1996; Granger, Huang & Yang, 2000; Murinde & Poshakwale, 2004; Inci & Lee, 2014; Lin, 2012; Chen & Chen, 2012; among many others). Bahmani-Oskooee and Sohrabian (1992) was the first study to suggest this feedback relationship between the two markets. Cointegration and the Granger test are employed using monthly data between 07/1973 and 12/1988. The results show that the interaction between exchange rates and stock prices in the US is bidirectional. Similar results are found by Ajayi & Mougoue (1996) for France, Germany, Italy, Japan, the UK and the US.

Following research on the developed market, bidirectional causality between exchange rates and stock prices is also found in emerging economies. For example, Granger, Huang & Yang (2000) study the short term dynamics between exchange rates and stock prices for a number of Asian countries during the Asian crisis, using daily data for the period 03/01/1986 to 16/06/1998. They conclude that Hong Kong, Malaysia, Singapore, Thailand, and Taiwan experience a significant feedback interaction between stock returns and exchange rates. Wongbangpo & Sharma (2002) confirm this finding for Singapore and the Philippines based on monthly observations between 1985 and 1996. With regard to European emerging countries, this bidirectional relation is found for the Czech Republic and Poland during the pre-Euro period by Murinde & Poshakwale (2004). This result can also be demonstrated by more advanced techniques. For example, Doong, Yang & Wang (2005) employ a GARCH-M model to study the dynamic causality between exchange rates and stock prices for Asian emerging markets. Using weekly observations over the period 06/01/1989- - 03/01/2003, they suggest a bidirectional relation between exchange rates and stock prices for Indonesia, Korea, Malaysia and Thailand. This is consistent with the findings of Pan, Fok & Liu (2007) for Hong Kong.

Even in recent research, there are some studies indicating feedback relations between exchange rates and stock prices. For example, Inci & Lee (2014) re-examine their dynamic relationship between the two by including lagged effects and causal relations, based on annual data over a long period from 1984 to 2009. They show that even this relationship is sensitive to the business cycle; there is significant evidence for bidirectional interactions between these two variables in France, Germany, Switzerland, the UK, the US, Canada, and Japan. Lin (2012) confirms this result for India, Indonesia and Korea. Similarly, Chen & Chen (2012) find non-linear bidirectional relations between exchange rates and stock prices for the US, Canada, Japan, Italy, France, the UK, South Korea and Hungary.

To sum up, the interaction between exchange rates and stock prices can also be bidirectional as found by a number of empirical studies. That is to say, the traditional approach and the portfolio approach can sometimes be observed at the same time in the real economy.

2.2.2.4 No relationship between stock prices and exchange rates

Although there are excellent theoretical frameworks for the interaction between exchange rates and stock prices, there are some studies that cannot find any relation between them in certain countries. (See, for example, Granger, Huang & Yang, 2000; Smyth & Nandha, 2003; Hatemi-J & Roca, 2005; Patra & Poshakwale, 2006; Ehrmann Fratzscher & Rigobon, 2011; Chen & Chen, 2012; among many others) For example, even though Granger, Huang & Yang (2000) find evidence for the traditional or portfolio approach in some countries, there is no evidence of any relationship between exchange rates and stock prices in Indonesia and Japan. A similar result is found for Bangladesh and Pakistan by Smyth & Nandha (2003). Hatemi-J & Roca (2005) studied this dynamic causality in the Asian crisis period. The result shows that stock prices were not affected by exchange rates, or vice visa for Malaysia, Indonesia, the Philippines and Thailand, during the Asian crisis. In the same year, Mishra (2005) found that the Indian stock market is not related to its foreign exchange market, which is in line with the arguments of Hatemi-J & Roca (2005). Patra & Poshakwale (2006) examined the adjustments of stock prices and certain macroeconomic variables including inflation, money supply, trading volume and exchange rates in Greece. They conclude that the Athens stock exchange is not related to its foreign exchange market, using monthly data from 1990 to 1999 in their analysis. Recent studies also confirm this indication. For example, there is no evidence of any short-term relations between exchange rates and stock prices in the US, as suggested by Ehrmann Fratzscher & Rigobon (2011). Similarly, it is difficult for Chen & Chen (2012) to find any linear causality between these two variables for France, Japan, Poland and Hungary.

In conclusion, some studies have found no evidence for either the traditional approach or the portfolio approach, indicating that exchange rates and stock prices might not be related in certain countries in empirical literature.

2.2.2.5 Long-term relationship between stock prices and exchange rates

As well as the four short-term relationships between exchange rates and stock prices, empirical studies notably also examine long-term interaction between them. Cointegration techniques including the Engle and Granger (EG) two-step method, the Johansen-Juselius (JJ) method and Johansen's non-linear GH test are usually employed to study the long term dynamics between these two markets.

Many studies suggest that there is no cointegration between exchange rates and stock prices, indicating that there are no long-run relations between these two markets (See, for example, Bahmani-Oskooee and Sohrabian, 1992; Nieh & Lee, 2001; Smyth & Nandha, 2003; Stavarek, 2005; Patra & Poshakwale, 2006; Alagidedea, Panagiotidi & Zhang, 2011; among many others). For example, Bahmani-Oskooee & Sohrabian (1992) was the first to suggest that there was no relation between exchange rates and stock prices. They investigated long-term cointegration for the US using monthly data from 07/1973 to 12/1988 and found no evidence for cointegration. Nieh & Lee (2001) again confirm this result for G7 countries. Stavarek (2005) also investigated this long-term relation for a number of countries including Austria, the Czech Republic, France, Germany, Hungary, Poland, Slovakia, the UK, and the US between 1970 and 1992. The stock market and the foreign exchange market are not found to be related to each other during this period, which can be explained by the Brettonwood system with fixed exchange rates. Moreover, the results of Yau & Nieh (2006) for Taiwan and Japan are also consistent with the previous studies. In other words, there is no evidence of any interaction between exchange rates and stock prices in Taiwan and Japan. (Yau & Nieh, 2006) More recently, Australian, Canadian, Japanese, Swiss and British foreign exchange and stock markets have been found to be unrelated by Alagidedea, Panagiotidi and Zhang (2011) using cointegration techniques. These results are not exclusive for developed markets. For example, Smyth & Nandha (2003) found no cointegration between exchange rates and stock prices for Bangladesh, India, Pakistan and Sri Lanka, using daily data from 1995 to 2001. Similarly, Doong, Yang & Wang (2005) also failed to find any interaction between these two variables in the long-term for Indonesia, South Korea, Malaysia, Thailand, Taiwan and the Philippines. Patra & Poshakwale (2006) agreed with these findings when investigating this issue in Greece.

However, a negative long-term relationship between exchange rates and stock prices is also found by some academics. (See, for example, Ajayi & Mougoue, 1996; Wongbangpo & Sharma, 2002; Kim, 2003; among many others) For example, Ajayi & Mougoue (1996) employed the cointegration technique to study long term interactions between stock returns and exchange rates changes using daily observations over a period between 04/1985 and 07/1991. They concluded that these two markets are negatively related in France, Germany, Italy, Japan, the UK and the US. Similar results are found for Singapore and Thailand by Wongbangpo & Sharma (2002). In addition, Kim (2003) employed the multivariate cointegration method and error correction model to examine long-run equilibrium relationships among several macroeconomic variables including aggregate stock price, industrial production, real exchange rate, interest rate, and inflation. The empirical result shows that S&P 500 stock price is negatively related to real exchange rate in the US.

On the other hand, literature also suggests that stock prices can be positively related to exchange rates. (See, for example, Solnik, 1987; Wongbangpo & Sharma, 2002; Phylaktis & Ravazzolo, 2005; Ratanapakorn, & Sharma, 2007; among many others) Solnik (1987) was the first to find weak evidence for the positive long-run cointegration between exchange rates and stock prices. Financial variables such as stock prices, rather than macroeconomic variables, are employed to test the exchange rate models. It is found that in Canada, France, Germany, Japan, the Netherlands, Switzerland, the UK and the US, increases in the stock market are associated with currency appreciation. Similar results are found by Ratanapakorn, & Sharma (2007) for the US as well. The long-term relationship between stock index (S&P 500) and the six macroeconomic variables is examined using monthly observations from 01/1975 to 04/1999. Exchange rates are found to be positively related to stock returns in the long run. This positive interaction between exchange rates and stock prices can not only be found in developed markets, but also in emerging markets. For example, Phylaktis & Ravazzolo (2005) studied this issue in a group of Pacific Basin countries. They found that foreign exchange and local stock markets are linked by the US stock market in Hong Kong, Malaysia, Singapore, Thailand and the Philippines. This is in line with the empirical results by Wongbangpo & Sharma (2002) for Indonesia, Malaysia and the Philippines.

In summary, from a careful review of research on the debate on the relationship between exchange rates and stock prices at macro level, there is no consensus on either long-term relations or the short-term Granger causality. In addition, neither the theoretical nor the empirical studies reach an agreement about the interaction between exchange rates and stock prices. That is to say, this relationship on the macro level is sensitive to the different markets analysed, estimation method and time period.

2.3 Interaction between stock prices and exchange rates--micro level

At micro level, the main research interest in the debate about the interaction between exchange rates and stock prices lies in the issue of “foreign exchange rate exposure”. In other words, people are interested in whether foreign exchange rate risk is priced in stock prices, and what the economic significance of this is. In finance theory, an asset's return is positively related to its risk. In other words, higher return is required for bearing higher risk. Therefore, stock price is usually determined by its riskiness. In terms of foreign exchange rates, the stock prices of both multinational and domestic firms are exposed to exchange risks. On one hand, the cash flows of multinational firms will naturally be affected, due to import or export activities as well as international plant, owing to the effect of selling prices denominated in foreign currencies and then sales. On the other hand, even with domestic companies, changes in exchange rates will have an impact because of the competitive environment and imported inputs. (Bodnar et al., 2003, Aggarwal & Harper, 2010, Hutson & Stevenson, 2010) Therefore, exchange rate risk should ideally be priced in stock prices, as suggested by financial theory. Therefore, this section will review research on exchange rate exposure and will include modelling issues and empirical findings.

2.3.1 Modelling issues

Foreign exchange rate exposure is defined as the sensitivity of the value of an asset to changes in foreign exchange rates, based on Adler and Dumas (1984). More precisely, the established framework usually employs the regression between exchange rates and assets to study exposures to foreign exchange risk. Regarding the exposures of stock prices to the foreign exchange risk, research suggests two measurements. One is total exposure, measured by a single factor market model, as illustrated in the following equation. (Aggarwal, 1981; Adler & Dumas, 1984)

$$r_t^i = \alpha + \beta_{total} x_t + \varepsilon_i \tag{2.3}$$

Where, r_t^i is the stock return of firm i over a period t, x_t is the exchange rate changes of any currency or currency index over time period t. Equation (2.3) indicates that β_{total} measures firms' total stock price exposures with regard to foreign exchange rates. Jorion (1991) extended this model to include a market index, in addition to the exchange rates as repressors in the asset pricing model. This two-factor model can be written as follows.

$$r_t^i = \alpha + \beta_i r_{m,t} + \beta_{residual} x_t + \varepsilon_i \tag{2.4}$$

$r_{m,t}$ is the return on the stock market index over time period t and everything else is defined as above. In equation (2.4), $\beta_{residual}$ measures firms' residual exchange exposure to foreign exchange exposure to the market. (Aggarwal & Harper, 2010) This two-factor model is the most widely used one in exchange rate exposure studies. (See, for example, Bartov and Bodnar, 1993; Vassalou, 2000; Muller & Verschoor, 2006; Bartram & Bodnar, 2012; Pan & Liu, 2012; among many others) Based on these models, there are a number of different extensions with which we can measure foreign exchange exposure, by adding other factors as independent variables. One famous model is proposed by Fama and French (1992) and can be stated as equation (2.5).

$$r_t^i = \alpha + \beta_i MRP_t + SMB_t + HML_t + \beta_{residual} x_t + \varepsilon_i \qquad (2.5)$$

Where MRP_t is the market risk premium, which is the difference between market index return and risk free return, SMB_t refers to the size effect in the stock market and is defined as the difference between small stock returns and large stock returns. HML_t is also included, to measure the value effect observed in stock returns, which is defined as returns of value stocks minus growth stocks. Therefore, $\beta_{residual}$ is foreign exchange exposure as defined above.

As well as the issues of model selection for exchange rate exposure measurement, there are also other problems in the empirical studies. The first one is the choice of currency used in exposure research. Many studies employ trade-weighted exchange rates, which are a basket of currencies. The reason is that this kind of exchange rate will capture the economic-wide change in home currency and will represent the environment that, on average, a firm will face. There are some trade-weighted exchange rates available, such as The Major currency for dollars and The Board exchange rate for sterling by the Bank of England, to name but a few. However, this measurement might be not appropriate if a firm is only significantly exposed to one or two currencies. In this case, it is suggested that specific bilateral exchange rates, where a firm has relatively higher exposures because of trade or foreign operations, are used. Williamson (2001), Koutmos and Martin (2003), Priestley & Ødegaard (2007) and other academics have demonstrated that misleading estimates by trade-weighted exchange rate can be rectified by using individual currencies. Besides, industry-specific or firm-specific exchange rates are regarded as representing the competitive environment and trade pattern of an industry or a firm very well, and thus being more precise for exchange rate exposure (Pan & Liu, 2012). However, there is no such exchange rate available directly from any database. This kind of exchange rate therefore needs to be calculated by hand and requires specific trade information from an industry or a firm. Hence, although ideally this measurement is better, there is little research that uses it.

Another problem encountered in empirical studies is the appropriate time horizon for exchange rate exposure measurement. On the one hand, researchers debate using contemporaneous or lag exchange rates in the measurement. Although efficient market hypothesis indicates the natural contemporaneous effect of these two markets, there are some studies finding lagged effect (See, for example, Bartov and Bodnar, 1994; among many others). On the other hand, the frequency of data used for estimation is also an issue. Daily, weekly, monthly, quarterly and annual data have all been used in exposure literature. In general, it is suggested that the significance of exchange rate exposure increases greatly with the time horizon. (Chow et al., 1997; Bodnar and Wong, 2003; et al.)

Moreover, the matter of whether currency exposure is conditional or unconditional is also much discussed in research. Several studies have found significant conditional exchange rate exposure, which is time-varying, asymmetric and non-linear (See, for example, Gao, 2000; Williamson, 2001; Tai, 2007; among many others). However, unconditional exposure is also suggested by some studies, such as those by Choi & Prasad, 1995 and Chaieb, & Mazzotta, 2013, to name but a few.

In addition, recent studies question the employment of "actual" changes in exchange rates as proxy for anticipated currency changes. Early studies usually use "realized" exchange rate movement to measure the foreign exchange exposure of a firm's value. However, Bredin & Hyde (2011) and Jongen, Muller & Verschoor (2012) state that firms should only be exposed to unexpected changes in exchange rates, since anticipated variations have already been priced in the firm's value.

In summary, although foreign exchange rate exposure has been well analysed by theory and widely discussed at firm level for almost thirty years, there are also many concerns about modelling and estimating in empirical studies.

2.3.2 Empirical evidence

This section will review the main findings with regard to exchange rate exposure in empirical studies. Early studies are found mostly in developed countries, such as the

US, Japan and Australia. Most exchange rate exposure literature is carried out in the US (See, for example, Jorion, 1990; Jorion, 1991; Bartov & Bodnar, 1994; Choi & Prasad, 1995; Chow, Lee & Solt, 1997; Gao, 2000; Allayannis & Ihrig, 2001; Muller & Verschoor, 2006a,b; Tai, 2007; Priestley & Ødegaard, 2007; Kolari et al, 2008; Jongen, Muller & Verschoor, 2012; Lee & Suh, 2012; Pan & Liu, 2012; Chaieb & Mazzotta, 2013; among many others). For currency exposures of US multinationals, early studies fail to find significant exchange rate exposures. For example, Jorion (1990) found that less than 10 out of 40 US firms are significantly exposed to exchange rate risks. More specifically, Jorion (1991) employed both the two-factor and the multi-factor model to estimate currency exposure, using monthly stock returns and exchange rates over the period January 1971 to December 1987. The unconditional currency premium appears to be small and insignificant. Bartov & Bodnar (1994) even found similar results when using the total exposures from 2264 firm-quarter observations. Instead of stock returns, abnormal returns were employed in their analysis. There is no evidence to show the effect of changes in the dollar on the sample's abnormal returns. More recently, Lee & Suh (2012) examined the effect of exchange rate changes on an operation's profitability. There is no evidence to show that the foreign operation's profitability is affected by currency fluctuations in the majority of industries. This finding is consistent with previous research on the failure of exchange rates to have a significant effect on firm value. However, the significance of currency exposure is seen as much more important in later studies. Choi & Prasad (1995) were one of the first to find significant exchange rate exposure for the US. To be specific, they confirmed that changes in exchange rates do affect stock prices, using residual exposure measurement by a two-factor model. It is suggested that around 60% of US multinationals benefited from dollar depreciation between 1978 and 1989. Allayannis & Ihrig (2001) demonstrated these findings by developing a partial equilibrium model, and used this model on US manufacturing industries. They found that a 1% appreciation of the dollar can lead to a 0.13% decrease of industry return on average, between 1979 and 1995. The level of significance is also greatly increased by new estimation methodology. For example, Gao (2000) considered time-varying currency exposure for the US and found a significantly negative impact of the US dollar on US multinationals' abnormal returns. Chaieb & Mazzotta (2013) investigated time-varying exposures as well. In contrast with firm-by-firm analysis in the previous research, the panel approach was used in order to provide an industry exposure benchmark for risk managers. It concluded that there is a statistically significant and sizeable unconditional exposure in the US. Asymmetric or non-linear currency exposure is also considered in recent studies. For example, Tai (2007) found strong evidence of asymmetric exchange rate exposure at industry level. When employing this asymmetric currency exposure, is the study found that 58% of US industries are significantly affected by currency movements. This result is consistent with the findings of Muller & Verschoor (2006). Kalari et al (2008) employed monthly data and two-year rolling periods in July each year for the US between 1975 and 2002, and discovered that foreign exchange risk is negatively priced in a cross-section of US stock returns during the period 1973 to 2002, and that the relationship between expected return and foreign exchange risk is nonlinear. This non-linear exposure is also suggested by Priestley & Ødegaard (2007), who added market portfolio and macroeconomic variables to the exposure estimation. They found that US multinationals are nonlinearly and significantly exposed to bilateral exchange rates. In addition, there some new methodology has also been employed for exchange rate exposure researches in the US over the last two years. For example, Pan and Liu (2012) calculated industry-specific exchange rates that can usefully reflect the competing environment and trade pattern for each industry. This measurement significantly increases the number of US industries which are affected by exchange rates. In addition, Jongen, Muller & Verschoor (2012) proposed a new methodology to model unanticipated exchange rates rather than "realized" exchange rates movements, as has been the case with existing research. Hence, stronger exposure estimates are obtained for US firms over the period from March 1999 to December 2009, than from traditional modeling.

Other advanced markets also attract a great deal of interest with regard to the currency exposure issue. In Japan, there are many researchers suggesting significant exchange rate exposure (See, for example, Choi, 1998; He & Ng, 1998; Doukas et al., 1999; Dekle, 2005; Tai, 2010; among many others). Early studies of Japanese markets can be found in Choi (1998), He & Ng (1998) and Doukas et al. (1999). Choi (1998) has investigated this issue in the Japanese stock market for the period 01/1973 - 12/1995. The study demonstrated that exchange rate is priced both in a conditional model and an unconditional multi-factor model, although exchange risk pricing may be sensitive to periods. In the same year, He & Ng (1998) employed a two-factor model and found that 25% of Japanese firms are significantly positively exposed to currency risk. A similar result was found by Doukas et al. (1999) for Japan, when using an intertemporal asset pricing methodology for the period from January 1975 to December 1995. More recently, Dekle (2005) studied exchange rate exposure for Japanese export industries and found higher exposure sensitivities (2.5%) than in previous research. Tai (2010) employed the advanced multivariate GARCH in mean (MGARCH-M) model to re-examine currency exposure in Japan. Using this methodology, strong evidence of time-varying currency risk premium and significant exchange rate exposure are found for the Japanese market.

The Australian market is also an attractive market for exchange rate exposure studies (See, for example, Loudon, 1993; Khoo 1994; Iorio & Faff, 2001; Brooks, et al., 2010; among many others). However, there is little evidence of significant exposures there. Studies of currency exposure for Australian multinationals can be traced back to 1993. Loudon (1993) used the classic two-factor model to examine whether foreign exchange risk is priced in Australian firms. Using monthly data from January 1984 to December 1989, only 4.6% of the sample is found to experience a significant exposure. A similar result was obtained by Khoo (1994), who suggested a very small proportion for exchange rates to explain stock prices in Australia. Iorio & Faff (2001) provided a more insightful understanding of currency exposure in Australia. They suggested that although contemporaneous changes in exchange rates might not affect stock prices, they have a significant lagged effect on stock prices. In addition, bilateral exchange rates are suggested to be better than aggregated exchanges rate indices when examining exchange rate exposure for Australian multinationals. Although Brooks, et al. (2010) considered the time-varying asymmetric effect of currency exposure, there is also limited evidence showing significant exposures for Australia.

There are an increasing number of studies of other single developed markets such as the UK and the Netherlands. For example, Ahmed, Omneya & Amr (2007) examined currency exposures for UK non-financial companies. More firms were found to be significantly exposed to foreign exchange rate risk than those reported in earlier studies. Specifically, more than 50% of UK non-financial firms were found to benefit from pound appreciation. Following their research, Ampomah, Mazouz & Yin (2012) re-examined exchange rate exposures for UK non-financial firms using the classic model. As many as 85.13% of firms can have significant currency exposure when time-varying exposures are used in the analysis. In addition, over 50% of Dutch firms are suggested to be significantly affected by exchange rate movements. (Jong, Ligterink & Macrae, 2006)

Besides these studies in a single market, there are also a number of studies investigating exchange rate exposure in a multi-country context (Bodnar, & Gentry, 1993; Prasad and Rajan, 1995; Vassalou, 2000; Koutmos & Martin, 2003; Muller &

Verschoor, 2006b; Hutson & O'Driscoll, 2010; et al.). Bodnar, & Gentry (1993) were the first to suggest significant exposures for Canada, Japan and the US. A similar result was found for Germany, Japan the UK and the US by Prasad and Rajan (1995). Dumas and Solnik (1995) confirmed these significant exposures for Germany, the UK, Japan and the US using conditional and time-varying exposure measures. Later on, De and Gerard (1998) offered more insights on the relationship between exchange rate and share price at micro level. The monthly data from the same time period used by Choi, et al. (1998) were employed in their research, and they found that there is currency risk premium in the equity market in Japan, the UK and the US although it is small for the sample as a whole. Moreover, for the period between 1980 and 1985, negative currency premium drove the total premium to be negative in some cases while currency risk premium only accounted for 6% of total risk premium in the period between 1989 and 1995. Williamson (2001) studied time-variation in exchange rate exposure in US and Japan automotive firms especially. Significant time-varying exposures were found for automotive firms in these two markets. Similarly, Koutmos & Martin (2003) suggested that around 40% of firms in Germany, Japan, the UK and the US experience asymmetric exchange rate exposure. However, Rees & Unni (2005) suggested a lagged effect of exchange rate on stock prices rather than contemporaneous ones for France, Germany and the UK. Ten countries including Australia, Canada, France, Italy, Switzerland, the Netherlands, Japan, Germany, the UK and the US were investigated by Vassalou (2000). In general, exchange rate risk is priced in all stock markets. Muller & Verschoor (2006b) employed 817 European multinational firms to examine currency exposures. In the long term, the significance level of currency exposure can be more than 65% for European firms. More recently, Hutson & O'Driscoll (2010) used a larger sample including 1154 European firms from 11 countries to re-examine exchange rate exposures after the euro period. Exchange rate risk is suggested to be increased after the introduction of the euro.

Foreign exchange rate exposure is also studied in the emerging markets (See, for example, Bailey & Chung, 1995; Kiymaz, 2003; Carrieri et al, 2006; Parsley & Popper, 2006; among many others). Bailey & Chung (1995) studied the effect of exchange rate on stock prices in an emerging market, Mexico. Using the multifactor model with exchange rate and political risk factors over the period January 1986 to June 1994, there is significant evidence for time-varying currency premiums in Mexico. Later, Kiymaz (2003) re-examined exchange rate exposure in another emerging market, Turkey. Around 60% of Turkish firms were found to be significantly affected by exchange rates. Then, Carrieri et al (2006) began to study this issue in several emerging market including six in Latin America and six in Asia. They found that there were significant emerging market currency risk premiums to both emerging market and developed market assets, by employing monthly data for a period from 01/1976 to 12/2003. At the same time, Asia-Pacific markets were also studied by Parsley & Popper (2006). Their results show that there were significant total exchange rate exposures for many Asia-Pacific firms. Exchange rate pegs have little effect on reducing these exposures. In addition, there are also studies providing a large sample, using both developed and emerging markets. For example, Doidge, Griffin & Williamson (2006) employed a large sample of 17,929 firms from 18 non-US countries. Instead of assuming linear exposures, the portfolio approach was applied and significant exposures were found. Dominguez and Tesar (2006) also constructed a sample consisting of 8 non-US industrialized and emerging markets to study the interaction between exchange rates and stock prices at firm level. Using weekly data over the 1980–1999 periods, firms were found to be dramatically affected by changes in exchange rate. The largest sample set, including 37 countries, was employed recently by Bartram & Bodnar (2012). Firms are suggested to be significantly affected when conditioning on exchange rate movements. Most importantly, the economic significance of exchange rate exposure is emphasized in this study. Although some of the individual series might experience insignificant exposures, these exposures are meaningful in terms of explaining cross-sectional returns.

2.3.3 Determinants of exchange rate exposure

In this section, studies of the determinants of foreign exchange exposure are reviewed in order to identify potential reasons why there is a huge difference in currency exposures among various firms. Previous research suggests that three types of firm characteristics are important for exchange rate risk: firm size, leverage and foreign activities. This section will examine the effect of these three variables specifically.

2.3.3.1 Firm Size

It has been well documented that firm size is an essential explanation for various exchange rate exposures. The relationship between firm size and its exposure is ambiguous. On the one hand, large firms are more internationally-oriented and thus are more exposed to foreign exchange rates. For example, He and Ng (1998) found that foreign exchange rate exposure increased with firm size for Japanese corporations between 1979 and 1993. This result is consistent with Bartram (2007), who found that large firms are associated with higher foreign exchange rate exposure, with regard to the Canadian dollar and the euro in the US. Similarly, Francis et al (2008) studied the US industry currency exposure and claimed that size has a significant positive impact on foreign exchange exposure. On the other hand, large firms tend to hedge more than small firms, which might reduce exposure. There are fewer hedging costs for larger corporations because of economies of scale, and thus more hedging activities are associated with less exposure. For example, Allayannis & Ofek (2001) suggested that the decision to hedge is positively related to the size of the firm, which is consistent with Nance, et al (1993). A later study by Hagelin & Pramborg (2006) also confirmed that the likelihood of using financial hedges increases with firm size. Similarly, Bartram et al (2009) found a positive relationship between hedging activities and firm size for 7319 companies in 50 countries. In particular, Bodnar, et al. (1995) employed a survey of risk managements on 2,000 US firms from over 40 industries and received

530 usable responses. Based on this extensive dataset, they found that 65% of large firms, whose market value is more than $250 million, use derivatives. However, only 12% of small firms with less than $250 million market value use derivatives. The findings are confirmed by later two more detailed surveys by Bodnar, et al. (1996) and Bodnar, et al. (1998). Similar conclusions were made by Berkman, et al (1997), who carried out a survey of derivatives for 79 New Zealand firms. They claimed that the use of financial derivatives rose as the size of the firm increased. While 100% of firms with equity market value greater than $250 million will use derivatives, for firms with equity market value less than $250 million, only 36% hedge by derivatives. Judge (2006) employed a survey of 400 UK non-financial companies and found that large firms hedge more than small ones. (Judge, 2006) Furthermore, it is much easier for large firms with more international activity to locate their factories in foreign markets, which can operationally hedge exchange rate risks. For example, Aggarwal and Ramaswami (1992) sent questionnaire to the President or CEO of 536 firms in the US equipment leasing industry. Using factor analysis, they found that there is a potentially higher limit for small and less multinational firms entering into the foreign market. Pantzalis et al (2001) studied foreign exchange rate exposure of US multinational corporations and found that fewer exchange exposures are linked to diversified operations across countries (Pantzalis et al, 2001). Therefore, because of hedging activities, many studies found that there is a negative relationship between firm size and its exchange rate exposure. For example, Dominguez & Tesar (2006) found that firm size is statistically significant for six out of the eight countries, and the

sign on the coefficients suggests that large- and medium-sized firms are likely to have lower levels of exposure than the excluded category, small firms. More recently, studies by Aggarwal and Harper (2010) found a significantly consistent and negative relationship between size and foreign exchange exposure. Similarly, Hutson and O'Driscoll (2010) found that smaller firms are significantly more exposed to exchange rate risk than large ones. Furthermore, Huffman, Makar and Beyer (2010) suggested that firm size is an important determinant of higher foreign exchange rate exposure, despite the fact that the SMB factor had already be considered when estimating foreign exchange rate exposure using the Fama-French three factor model. With emerging market companies, Chue and Cook (2008) found that small firms are still significantly more exposed to exchange risks, based on an instrumental-variable approach. Hutson and Stevenson (2010) confirmed this inverse relation between exchange rate exposure and firm size by studying 3788 firms from 23 developed countries. In addition, some researchers found mixed results. For example, Bodnar & Wong (2003) claimed that small firms tend to have positive exposures regardless of the degree of operations, while large, more internationally-oriented firms tend to have negative exposures. In addition, Francis, et al (2008) employed US industry-level data and found that currency exposures were significantly positively related to firm size in developing countries' currencies, but that exposure will be negatively affected by firm size in industrialized countries' currencies.

Therefore, size is regarded as one important factor affecting foreign exchange rate exposure, and the effect can be either positive or negative.

2.3.3.2 Leverage

Leverage can be seen as a proxy for the firms' incentives to hedge, and it has been suggested that it can also be related to exchange rate exposure. He & Ng (1998) suggested that firms with a high level of debt in their capital structure are more prone to financial distress and therefore are more inclined to hedge in order to reduce the earnings' volatility. However, there is no coherent answer to the question of how financial leverage affects currency exposure. On the one hand, firms with a greater level of debt in their capital structure are suggested to be more affected by foreign exchange rate movements. For example, Francis et al (2008) found a significant positive relationship between leverage and foreign exchange rate exposure based on the US aggregate- and industry-level data. Hutson and Stevenson (2010) also confirmed this result by studying exchange rate risk for the period 1993-2003. Similarly, Aggarwal and Harper (2010) found fairly consistent results based on different estimation horizons: one month, three months and a year. The level of foreign exchange exposure always increases with the rise of financial leverage usage. However, there might be an inverse relation between leverage and exposure depending on hedging. For example, He and Ng (1998) found a significant negative relationship between leverage and exchange exposure for Japanese multinational corporations. This negative relationship is mainly explained by hedging activities, which greatly reduce foreign exchange rate exposure. In addition, Chue and Cook (2008) studied foreign exchange exposure for 15 emerging markets and found that debt to market capitalization ratio is significantly negatively related to firms' currency exposure for the period between 1999 and 2002. Research has suggested that higher leveraged firms tend to employ more hedging activities, thus making final exchange rate exposure less. For example, Nance et al (1993) claimed that hedging activities are more valuable for firms with a higher leverage ratio. Furthermore, Judge (2006) studied the hedging activities of UK companies and found that gearing ratio is positively related to the likelihood of corporation hedging.

In conclusion, the impact of leverage on the changes in exchange rate pass through into stock prices is also suggested by research, and the effect is uncertain.

2.3.3.3 Foreign sales

Foreign sales are found to be essential in explaining various foreign exchange rate exposures in previous research. The effect of foreign sales ratio on firms' exposure is mixed. Many researchers have claimed that there should be greater currency exposures for firms with higher foreign sales. For example, Jorion (1990) suggested a significant positive relationship between foreign sales and currency exposure for the US multinationals. Similar results have been found by Choi and Prasad (1998), who employed foreign sales rather than foreign sales as ratios of total sales for the US multinational firms. Allayannis & Ofek (2001) used a sample of S&P 500 non-financial firms for 1993 and found a strong positive relationship between exchange-rate exposure and foreign sales ratio. Later, Bartram (2007) also studied foreign exposures for the US companies and supported the findings that multinational firms experience greater currency exposures than domestic ones. Huffman, Makar and Beyer (2010) confirmed that firms with higher levels of foreign sales tend to be more exposed to foreign exchange rate risks. Moreover, based on market level data, Bredin and Hyde (2011) also suggested a positive relationship between openness and exposure. However, there is also some evidence to demonstrate a negative relationship between foreign sales and exposure. For example, Bodnar & Wong (2003) suggested a significant negative impact of foreign-and-export sales ratio on currency exposure. This negative relationship implies that firms with a higher foreign-and-export sales ratio should gain from currency depreciation. This can be explained by hedging activities. Foreign sales are also found to be the important determinants in a firm's decision to hedge, and the amount of hedging. Firms with higher exposures tend to hedge significantly more than those with lower ones. For example, Allayannis & Ofek (2001) found significant evidence for the positive relationship between foreign sales and probability of financial hedging. At the same time, Dominguez and Tesar (2001) also suggested that firms with more foreign activities tend to employ an increasing amount of derivatives and transaction hedging, which results in lower foreign exchange exposure. Later on, Judge (2006) conducted a survey for 400 UK companies and found out firms with higher foreign sales are more likely to hedge. In addition, Dominguez & Tesar (2006) studied firm returns and exchange rates from a sample of eight countries including Chile, France, Germany, Italy, Japan, the Netherlands, Thailand and the UK over the 1980–1999 period, and found that there is a significant positive relationship between exposure and international activity for Germany, Japan and the UK, while foreign sales ratio tends to be negatively related to exposures in Italy.

Therefore, foreign sales ratio must also needed to be considered as one determinant of currency exposure, although its impact is uncertain.

2.4 Share valuation models

2.4.1 Accounting models for stock valuation

Foreign exchange exposure is defined by research as sensitivity of the value of an asset to changes in foreign exchange rates. (Adler and Dumas, 1984) Therefore, when investigating the interaction between exchange rates and stock prices at micro level, we need to review the valuation of stock prices. In accounting theory, Damodaran (2005) suggested that a stock can be valued by three different approaches: the discounted cash flow valuation approach, the liquidation and accounting valuation approach and the relative valuation approach, as shown in Table 2.1.

It is easy to understand that equity value equals all future incomes, which are moderated by time value. Thus, the Discounted Cash Flow valuation approach was developed. It calculates stock as the sum of the present value of expected cash flows discounted back at a rate that reflects the riskiness of these cash flows. There are many models which use this valuation approach, for example the Dividend Discount model, the Gordon Growth model, the H-model, the Free Cash Flow to Equity model, the Free Cash Flow to Firm model, Utility models, Risk and return models and cash flow haircut models. (Damodaran, 2005). All these models are based on the assumption known as “going concern” in accounting literature. In other words, it is assumed that a company will continue its operation for an infinite time, and its value will be the sum of all the cash flows the company will generate in the future. This method is superior to other accounting-based valuation approaches because it will not be affected by the accounting method. As is well known in accounting theory and practice, accounting principles seem much more different in their actual application. Even in the most widely used reporting standards, the “U.S Generally Accepted Accounting Principles (GAAP)” and “International Financial Reporting Standards (IFRS)”, there are many differences, to say nothing of other local accounting standards. However, this method cannot always be accepted. For example, for a company which pays no dividends, the Dividend Discount model cannot be employed. Moreover, this valuation approach will provide an unreasonable estimation of firm value for distressed firms since the “going concern” assumption cannot be established.

Therefore, the Discounted Cash Flow valuation approach is usually employed for firms which pay regular dividends or are in a stable developing period.

Furthermore, as accounting theory has grown rapidly, the liquidation and accounting valuation approach has been developed. The proponents of this method believe that there is significant information in the book value of a firm's assets and equity. Therefore a stock is valued as the sum of book value of the assets and net liabilities. This method can take advantage of accounting information when valuing share prices, but at the expense of being sensitive to the accounting method. That is to say, it is impossible to compare company values in the US which use the GAAP and in Europe which use the IFRS. However, there is a unique advantage to this valuation approach. Since it can be assumed that all assets now have to be sold, we can obtain more realistic estimates of value for firms that are distressed. Therefore, the liquidation and accounting valuation approach is usually employed for mature firms with predominantly fixed assets and book value, which may yield a reasonable measure of true value; but for firms with significant growth opportunities, it will be very different from their true value. (Damodaran, 2005)

Finally, if market prices' individual assets are on average correct, we can value a stock by looking at what the market is paying for similar assets; Damodaran (2005) calls this the Relative Valuation approach. In practice, multiples such as price-to-earnings ratio and price-to-book value ratio are usually used in the valuation. Although this method generates a reasonable market value for a firm, it is usually difficult to find similar companies, thus making this valuation less popular.

Table 2.1: Stock price valuation approaches

Approach	Assumptions	Models	Advantages/ disadvantages
Discounted cash flow valuation	Going concern assumption, (Value is the present value of the expected CF discounted back at a rate that reflects the riskiness of these CF)	Risk adjusted discount rate models, certainty equivalent models, adjusted present value models	Will not be affected by accounting methods; Will give unreasonable estimation for distressed firms
Liquidation and accounting valuation	There is significant information in the book value of a firm's assets and equity	Ohlson residual income model	Use accounting data, Sensitive to the accounting method
	Assets have to be sold now	Liquidation value=book value, liquidation and discounted cash flow value relation	Yield more realistic estimates of value for firms that are distressed; Provide estimates of value for healthy firms with significant growth opportunities, that are too far too conservative.
Relative valuation	The market prices individual assets right on average (value by looking at what the market is paying for similar assets)	Multiples (price-to-earnings, price-to-book value. Etc.)	Similar companies might be difficult to find

Of all these valuation approaches, the Gordon Growth Model, Free Cash Flow model and Residual Earnings Model are the most widely used in empirical studies, and these are which are shown in Table 2.2.

Table 2.2: Comparison of Gordon Growth Model, Free Cash Flow model and Residual Earnings Model

Model	Assumption	Advantages	Disadvantages	When to use
Gordon Growth Model	1. Cost of equity and pay-out ratio are constant; 2. Higher growth	**1**. Simple **2**.Needs fewer assumptions **3**. Less volatile as managers set their dividend at levels that they can sustain even with volatile earnings	Abandons equity claims on cash balances and undervalues companies with large and increase cash balances, or overvalues the companies which pay dividends with new debt or equity issues	1. Establish floor value for firms that have cash flows to equity exceed dividends 2. Realistic estimates for firms that do pay out their free cash flow to equity as dividends (average) 3. When cash flow is difficult to estimate.
Free Cash Flow model	Use potential dividends instead of actual dividends	Consider the cash that could be paid out in dividend rather than the actual dividend	1.More assumption 2.More volatile	When there is sizable probability that a firm can be taken over or its management changed
Residual Earnings Model	Book value contains significant information for company value	Take advantage of accounting information	Sensitivity to the accounting method	Mature firms with predominantly fix assets

2.4.1.1 Gordon Growth Model

The Gordon Growth Model is one of the Discounted Cash Flow valuation approaches, and it takes the following form:

$$P_0 = \sum_{t=1}^{t=n} \frac{E(D_t)}{(1+r)^t} + p_n/(1+r)^n \quad (2.6)$$

Where, $p_n = \frac{E(D_{t+1})}{r-g}$ (2.7)

$$E(D_t) = \text{payout} - \text{ratio} * E(e_t) \quad (2.8)$$

Here, P_0 is equity price at time 0, and P_n is selling price at time n in the future. D_t and D_{t+1} are the dividend paid at the t^{th} year and the following year respectively. E() indicates the expected function and $\sum()$ is a function for summing up. For example, $E(D_t)$ means the expected dividend paid at time t. $\sum_{t=1}^{t=n} \frac{E(D_t)}{(1+r)^t}$ sums up all the present values of anticipated dividends from time 1 to time n. r is cost of equity, g is expected dividend stable growth rate, and e_t refers to a firm’s earnings during time t. We assume that companies’ initially grow at a faster rate than the stable rate; after n years, the company grows at stable growth rate g and we can sell the stock on the market at price P_n in the n^{th} year. The stock can be priced as the sum of the future dividends and selling incomes, both of which are discounted by the riskiness of the cash flows. Furthermore, all the variables here are predicted to be positive, with the exception of special environment. Both price and expected dividend cannot be less than zero in reality. This model indicates that a firm can be valued more if it pays more dividends to its shareholders. Moreover, cost of equity is expected to be positive in normal economic conditions since investors should be compensated for giving up consumption at time zero. However, expected dividend growth rate can be either positive or negative, since a firm can be in developing periods, a mature period or a downfallen period. In addition, cost of equity must be larger than expected dividend growth rate, otherwise the model will be mathematically invalid.

2.4.1.2 Free Cash Flow Model

Another popular Discounted Cash Flow model is Free Cash flow model, which uses potential dividends instead of actual dividends. As a result, it is more accurate than the Discounted Dividend model, since dividends are only one form of earnings that add to firm value. Specifically, free cash flow can be calculated in theory as the following equation:

FCFE = net income + depreciation - capital expenditures - change in non-cash working capital - (new debt issues - debt repayments) (2.9)

In other words, free cash flow to equity (FCFE) is net income adjusted by non-cash activities plus net revenue from debt financing. For example, due to "matching" principles in accounting theory, assets will be subtracted from depreciation in order to match revenues with expenditures. However, there is actually no cash outflow in this transaction, therefore we add depreciation back when calculating free cash flows to equity (FCFE). Similarly, a firm can be valued by summing up all expected cash flows adjusted by time value. If we assume the cash flows to equity for a company will experience stable growth rate g, the model can be written as follows:

$$P_0 = \frac{E(FCFE_1)}{1+r} + \frac{E(FCFE_2)}{(1+r)^2} + \frac{E(FCFE_3)}{(1+r)^3} + \frac{E(FCFE_4)}{(1+r)^4} + \cdots + \frac{E(FCFE_n)}{(1+r)^n(r-g)} \qquad (2.10)$$

Where $FCFE_t$ refers to cash flow to equity at year t, r is cost of equity and g is stable growth rate for free cash flows to equity. Compared to the Discounted Cash Flow model, this valuation model considers the cash that could be paid out in dividends rather than the actual dividend, thus making the valuation more appropriate for companies which do not pay dividends to shareholders. However, due to the introduction of free cash flow to equity, there are more assumptions in this valuation model. Furthermore, unlike dividends, free cash flow to equity is very volatile due to unexpected net income for a company, thus making the valuation volatile. In conclusion, when there is no dividend pay-out or there is a sizeable probability that a firm can be taken over or its management changed, the Free Cash Flow model will outperform the Discounted Dividend Model.

2.4.1.3 Residual Earnings Model

In the liquidation and accounting valuation approach, the residual earnings model has attracted much research interest. One possible reason is that it can take advantage of accounting data when valuing a stock. This approach believes that there is significant information in accounting data. The International Accounting and Standards Board (IASB) states that the objective of financial statement is to provide useful information to a wide range of users in making economic decisions. The information is about the financial position, performance and changes in financial position. Therefore, for people who lack information about a company's operations, accounting data on financial statements will provide a comprehensive and detailed picture of a company. For the Residual Earnings model (Residual Income model), it can be expressed as follows:

$$P_0 = B_0 + \frac{E(RI_1)}{1+r} + \frac{E(RI_2)}{(1+r)^2} + \frac{E(RI_3)}{(1+r)^3} + \cdots + \frac{E(RI_n)}{(1+r)^n(r-g)} \tag{2.11}$$

In this equation, B_0 stands for book value of equity at time 0, RI_n refers to the abnormal earnings or residual earnings generated at time n, r is cost of equity and g is stable growth rate of abnormal earnings. Therefore, the residual earnings model prices a company by adding discounted abnormal earnings to initial book value. Moreover, in accounting theory, abnormal earnings can be calculated from the following equation:

$$RI_n = e_n - r * B_{n-1} \tag{2.12}$$

That is to say, abnormal earnings are the difference between net income this year and book value last year adjusted for time value. Therefore, it is reasonable to value a firm as the sum of initial book value of equity and abnormal earnings for each year with an adjustment for time value. As we define abnormal earnings as residual earnings after some of the net income is used to purchase assets, abnormal earnings do add value to equity price. However, although there is significant information in the accounting data, the accounting method differs from country to country, and it does have an impact on valuation of stock. For example, in the US, companies can use the LIFO (last-in, first-out) method to record inventory because of its income tax benefits, while only the FIFO (first-in, first out) method for inventory recording is employed under IFRS in European countries, thus making revenues less under LIFO than under FIFO when there is a price rise in cost of goods. In addition, since the valuation is based on book value for some growing companies, fixed assets are changing greatly each year, thus making this valuation unrealisable. Instead, this model is more suitable for mature firms with predominantly fixed assets.

2.4.2 Empirical evidence on share valuation models

2.4.2.1 Discounted Dividend Model

This section reviews the empirical evidence about these three popular share valuation models. Firstly, there is a wide application of the Discount Dividend model in empirical studies. The Discounted Dividend Model is one of the most favoured and established of all valuation models. It attracted a great deal of debate about the practice immediately after it was introduced. On the one hand, the Discounted Dividend Model is supported by many empirical studies (See, for example, Rees, 1997; Brief & Zarowin, 1999; McMillan & Wohar, 2010; among many others). For example, Rees (1997) was among the first to study the implications of dividends in share valuation models. Using a large panel consisting of 8287 firm-year observations from the UK, the study found that stock values can be explained 6% more when dividends are included in valuation models. This was confirmed by Brief & Zarowin (1999). Dividends were found to have the greatest explanatory power, compared to earnings and book value, for firms with transitory earnings. Akbar & Stark (2003) also found that the influences of book value and earnings can sometimes be captured by dividends. More recently, Mcmillan & Wohar (2010) used the non-linear Discount Dividend model and concluded that the non-linear forecasting ability of the dividend-price ratio for international stock market returns is superior to both a linear and a symmetric exponential smooth-transition (ESTR) model. Furthermore, the Discounted Dividend Model is also used in many aspects of research. For example, Claus et al (2001) found that equity premium is around three percent (or less) in the US and five per cent in other markets, by employing the Gordon Growth Model. Fama and French (2008) employed the Dividend Discount model to investigate whether better estimates of stock returns can be provided by book-to-market ratio. By doing cross-sectional regression on stock prices from 07/1927 to 12/2006, they found that past share issues and past changes in price and book equity contain independent information about expected cash flows, thus enhancing estimates of expected returns. However, these findings are not agreed upon by many academics (See, for example, Benartzi, Michaely & Thaler, 1997; Barker, 1999; Jiang and Lee, 2007; among many others). For example, Benartzi, Michaely & Thaler (1997) argued against the Discounted Dividend Model and stated that dividends can only explain contemporary changes in earnings and have no explanatory power for future earnings. Moreover, Barker (1999) claimed that there is a limited effect of dividend yield for share valuation. The reason is that valuation is based on personal communications and embodying signaling because of information asymmetry. More specifically, Jiang and Lee (2007) suggested that spread should be a better indicator of intrinsic fundamentals than dividend yield or book-to-market ratio.

In summary, there is no consensus on the application of the Discounted Dividend Model in practice. As shown by Damodaran (2005), the Gordon Growth Model is simple and easy to understand and use. Another advantage is that valuation from this model is less volatile compared to other models, as managers set their dividends at levels that they can sustain, even with volatile earnings. Since declining dividends may transfer bad information about companies to the market, managers are usually reluctant to cut down their dividends. However, this might also lead to companies being overvalued, which pay dividends by new debt or equity issues. Furthermore, for companies with large and increasing cash balances, this model will undervalue them due to abandonment equity claims on cash balances. As a result, this model is suitable for valuing companies which do on average pay out their free cash flows to equity as dividends. Moreover, we can also establish floor value for firms that have cash flows to equity exceeding dividends with this model. In addition, when cash flows are difficult to estimate, this model can also be employed.

2.4.2.2 Free Cash Flow Model

The Free cash flow model also has many supporters (See, for example, Charitou & Clubb, 1999; Barth et al., 1999; Da, 2009; Da & Warachka, 2009; Akbar, Shah & Stark, 2011; among many others). For example, based on UK evidence between 1985 and 1992, Charitou & Clubb (1999) suggested that cash flow variables can increase the explanatory power of earnings, which is consistent with the findings of Barth et al. (1999). Cash flows can add explanatory power to the equity market, besides book value and abnormal earnings. Da (2009) has studied the relation between cash flows and stock prices in 2009 from two different perspectives. Firstly, Da & Warachka (2009) used a three-stage earning growth model to demonstrate that cash flow risk can explain value premium, size premium and long-term return reversals. Furthermore, Da (2009) employed the CAPM, CCAPM and Fama-French models respectively to study the relationship between cash flow characteristics and risk premium. The study proved that cash flow durations and cash flow covariance can explain up to 82% of the cross-sectional variation in the average returns. More recently, Akbar, Shah & Stark (2011) also studied the firm values of UK non-financial firms over a period from 1993 to 2007. The results show that there is incremental explanatory power of cash flows relative to earnings. They suggest using cash flow statements for UK investors in share valuation. Furthermore, there is also abundant evidence for the application of cash flows in valuing an asset in practice (See, for example, Demirakos, Strong & Walker, 2004; Imam, Barker & Clubb, 2008; Demirakos, et al., 2010; among many others). For example, Demirakos, Strong & Walker (2004) found that either a PE model or a multi period Discounted Cash Flow model is employed as the main valuation method in the UK, based on 104 analysts' reports from international investment banks. Imam, Barker & Clubb (2008) confirmed the importance of the Discounted Cash Flow model in valuation by semi-structured interviews and 98 equity research reports for FTSE-100 companies. Similarly, Demirakos, et al. (2010) employed a larger sample of UK firms during 2002 and 2004. 490 equity research reports for 94 UK-listed companies were examined. If the difficulty of valuation can be controlled, the Discounted Cash Flow model will outperform PE models, in terms of valuation accuracy. In addition, the Discounted Cash Flow model is used in many other areas. For example, Campbell, Polk and Vuolteenaho (2010) have decomposed stock price into two components, expected future cash flows and discount rates as discounted cash flow models suggest, and then decomposed the beta into beta for the expected cash flows and beta for the discounted rate. They found that cash-flow fundamentals of growth and value companies can determine high betas of growth (value) stocks with the market's discount-rate (cash-flow) shocks. Similarly, Chen and Zhao (2009) also decomposed the unexpected returns for a stock into two components:-one is driven by discount rate news and the other by cash flow news. By conducting regression on monthly data for a long period from January 1929 to December 2001, they found that CF beta, instead of total beta, is the more important measure of risk when calculating cost of equity. Moreover, they also agreed with Campbell, Polk and Vuolteenaho (2010) that higher CF betas lead to a higher return for value stocks. However, also based on discounted cash flow models, Hecht and Vuolteenaho (2006) decomposed the stock returns into three parts: one-period expected return, cash flow news and negative of expected-return news. They found that cash flow proxies can explain aggregate stock returns well, while they can only explain a small fraction of annual stock returns at firm-level. However, this valuation model is also questioned by some research (See, for example, Charitou, Clubb & Andreou, 2001; Liu, Nissim & Thomas, 2007; Imam, Chan & Shah, 2013; among many others). For example, Charitou, Clubb & Andreou (2001) failed to find significant evidence for cash flows as a better explanatory variable for stock returns, based on a large panel consisting of 3,364 firm-year observations between 1985 and 1993 in the UK. Liu, Nissim & Thomas (2007) asked whether cash flow is king in share valuation as well. They found that earnings should be better than cash flows for measures in the US. Therefore, they suggested that investors employ earnings multiples rather than cash flow multiples. The more recent study conducted by Imam, Chan & Shah (2013) also supports the application of the Residual Earnings model instead of the Discounted Cash Flow model, based on equity research reports for the firms listed in the Dow Jones Euro Stoxx 50 Index.

2.4.2.3 Residual Income Model

The Residual Earnings model is the most widely employed one in empirical studies (See, for example, Frankel & Lee, 1998; Stark & Thomas, 1998; Gebhardt et al., 2001; Baginski & Wahlen, 2003; Jiang & Lee, 2005; Habib, 2008; among many others). For example, Frankel & Lee (1998) suggested that more than 70% of the variation in cross-sectional stock prices in the US can be explained by the Residual Income model. At the same time, Stark & Thomas (1998) also found a consistent result for the UK. In particular, residual income was found to be more associated with market value than earnings, in addition to book value and RD expenses. Furthermore, Claus and Thomas (1998) showed that using the Residual Income model yields lower market risk premiums than using historical realized returns. This model was also used to calculate implied cost of capital by Gebhardt et al. (2001). Results showed that cost of capital based on this model is related to firm characteristics. This was never found when using historical realized returns for cost of capital calculation. Later on, Baginski & Wahlen (2003) incorporated risk in empirical applications of the Residual Earnings model and found that total volatility in this model has more explanatory power than abnormal ROE beta, for differences between observed share price and risk free rate. In other words, they confirmed using this model that abnormal earnings are the fundamental valuation attribute. Similarly, Jiang & Lee (2005) found evidence suggesting that the accounting- based Residual Earnings model provides a better valuation for stock price than the conventional Discounted Dividend model, since accounting earnings and book value contain more information than dividends alone. It is suggested that the accounting-based Residual Earnings model should be employed to forecast stock prices. More recently, Habib (2008) empirically investigated cash flows and earnings for share valuation in New Zealand firms. Although the difference is not significant, there is higher explanatory power of earnings relative to cash flows. However, the Residual Income model is also less accepted by some researchers. For example, Jiang & Stark (2012) questioned the role of book value for equity value determination suggested by the Residual Income Model. In addition, Chan, Karceski & Lakonishok (2003) worried about this model because they found the persistent long-term earnings growth difficult to predict.

2.4.2.4 Summaries of the three models

Since the development of these three share valuation models, there has been a long list of studies discussing which model works best (See, for example, Ohlson, 1990; Peman & Sougiannis, 1998; Lundholm & O'Keefe, 2001a, b; Penman, 2001; Courteau, Kao & Richardson, 2001; Jiang & Lee, 2005; Easton & Monahan, 2005; Subramanyam & Venkatachalam, 2007; Barton, Hansen & Pownall, 2010; among many others). One of the earliest studies was by Ohlson (1990). He argued that only expected dividends can be attributed to the present value of a security, and that the Discounted Cash Flow model could even bring more problems than it can solve, due to the additional assumptions. Of all the three models, the Residual Income model is suggested to be the best one for valuation. Peman & Sougiannis (1998) confirmed this conclusion by finding the lowest number of valuation errors for this one. Similarly, Francis et al. (2000) found that more variation in stock prices is explained by the Residual Income model, using five-year forecasts for 3000 firm-year observations over 1989-1993. These findings were challenged a great deal in 2001 and led to heated discussion that year. Courteau, Kao & Richardson (2001) argued that the superiority of the Residual Income model does not hold. Using Penman's (1997) theoretically "ideal" terminal value, the Discounted Cash Flow model should provide the same prediction as the Residual Income model. This is consistent with findings by Lundholm and O'Keefe (2001). The Discounted Dividend model and the Residual Income model are suggested to be conceptually and structurally equivalent, which should mean that identical valuations are yielded from all firms. However, Penman (2001) replied to Lundholm and O'Keefe (2001) and insisted that they were wrong. He argued that it is impossible for the models to be indifferent in finite-horizon forecasting. Later on, Jiang & Lee (2005) tried to explain the failure of the conventional Discounted Dividend model by inappropriate measurements of dividends. In contrast, they recommended the Residual Income model. Similarly, even using ex post-intrinsic value of equity, Subramanyam & Venkatachalam (2007) ascertained that the Residual Income model outperforms the Discounted Cash Flow model. However, Easton & Monahan (2005) suggested that none of the accounting-based measures are positively related to realized returns. Barton, Hansen & Pownall (2010) also indicated that none of the measures can always be the best one. Instead, they found that underlying attributes rather than performance of the measures are more relevant when valuing equities.

From all discussion above, we can come to the conclusion that although there are various models that can be employed in equity valuation, each model has its own advantages and usages. These can be summarized as follows. The Gordon Growth Model is more appropriate for higher growth companies while the Residual Earnings model is more suitable for mature companies with predominantly fix assets, and the Free Cash Flow model is usually employed when there is a sizeable probability that a firm will be taken over or its management changed. However, the Residual Income model is generally suggested to be superior to the other two models.

2.5 Stock price decomposition and variance decomposition

2.5.1 Theoretical framework

What drives stock price movements? This is a central question about stock prices. Campbell (1911) and Campbell and Shiller (1988) firstly decomposed unexpected stock returns into cash flow component and discounted rate, which can be seen as a milestone for stock returns. Then, many other researchers joined the discussion. Before reviewing the research on variance decompositions of stock returns, decomposition methodology will be introduced. Following this revolutionary research work, unexpected stock returns can be decomposed as the following equation:

$$\widetilde{e_{\iota,t+1}} = g_{t+1} - E_t g_{t+1} = (E_{t+1} - E_t)\sum_{j=0}^{\infty}\rho^j \,\Delta d_{t+1+j} - (E_{t+1} - E_t)\sum_{j=1}^{\infty}\rho^j r_{t+1+j}$$

$$= e_{\widetilde{d\iota,t+1}} - e_{\widetilde{e\iota,t+1}} \qquad (2.13)$$

Here, $D_{i,t}$ is dividends paid during the period of t, and g_t is one-period log holding return on stock i, ρ is a constant error approximation term of linearization defined as $\rho \equiv 1/(1+\exp(\overline{d_t - p_t}))$,and E refers to the expected function. All the lower case letters refer to log forms of variables. Hence, the equation shows that unexpected stock returns $\widetilde{e_{\iota,t+1}}$ can be simply decomposed into two components: $e_{\widetilde{d\iota,t+1}}$ denotes news or innovations about cash flows, and $e_{\widetilde{e\iota,t+1}}$ is news or innovations about future discount rates. For the ease of presentation, we suppress the time subscript when possible. Therefore, the market beta can be defined as:

$$\beta_i = \frac{Cov(e_i, e)}{Var(e)} \qquad (2.14)$$

Where e_i is the stock return of asset i and e is the market return. Cov() stands for the covariance function and Var() refers to the variance function. Then it can be further decomposed two parts as follows:

$$\beta_i = \frac{Cov(e_i, e_d)}{Var(e_i)} + \frac{Cov(e_i, -e_e)}{Var(e_i)} = \beta_{d,i} + \beta_{e,i} \qquad (2.15)$$

Where $\beta_{d,i}$ and $\beta_{e,i}$ are the cash flow beta and discounted rate beta for asset i respectively. In order to make the decomposition feasible, VAR methodology is always employed in empirical studies to obtain the proxies for unexpected returns about cash flows (CF news) and discounted rates (DR news) respectively. As research has suggested, a first-order VAR model to estimate these two components can be written as follows:

$$z_{t+1} = \alpha + \Gamma z_t + u_{t+1} \quad (2.16)$$

Where z_{t+1} is an m-by-1 state vector with g_{t+1} as its first element, α is a m-by-1 vector defined as constants and Γ is an m-by-m matrix of parameters, and u_{t+1} is an i.i.d. m-by-1 innovation. Provided the above VAR generates the data, the unexpected effects on cash flows and discount rates are suggested to be linear functions of the t+1 shock vector, as shown below:

$$-\widetilde{e_{et}} = -(E_{t+1} - E_{t+1})\sum_{j=1}^{\infty}\rho^j r_{t+1+j} = e1'\sum_{j=1}^{\infty}\rho^j\Gamma^j u_{t+1} = -e1'\rho\Gamma(I - \rho\Gamma)^{-1}u_{t+1} = -e1'\lambda u_{t+1} \quad (2.17)$$

Then, the CF news can then be backed out as the difference between the total unexpected return and the DR news. Therefore, the CF news and DR news can be obtained as follows:

$$\widetilde{e_{e\iota}} = \mathrm{el}'\lambda u_{t+1} \quad (2.18)$$

$$\widetilde{e_{d\iota}} = (\mathrm{el}' + \mathrm{el}'\lambda)u_{t+1}; \quad (2.19)$$

Where, $\widetilde{e_{ei}}$ is the discount rate news, DR news; and $\widetilde{e_{di}}$ is the cash flow news, CF news, e1 is a vector with the first element equal to unity and the remaining elements are zero. The VAR shocks then can be mapped to cash flow related effects and discount rates related effects by λ, defined as $\lambda \equiv \rho\Gamma(I-\rho\Gamma)^{-1}$. (Campbell, Polk and Vuolteenaho, 2010) Γ is the VAR parameter estimate matrix, I is an identity matrix, and ρ is a linear parameter and is set to 0.95 followed literature here[1]. The greater value of a factor's coefficient in the return prediction equation will lead to more effect through the discounted rate channel. Then the betas of components can be defined as follows:

$$\beta_{d,i} = (e1' + e1'\lambda)\frac{Cov(e_{i,t}, u_t)}{Var(e)} \tag{2.20}$$

$$\beta_{e,i} = -e1'\lambda\frac{Cov(e_{i,t}, u_t)}{Var(e)} \tag{2.21}$$

2.5.2 Empirical evidence

The introduction of the return decomposition framework has drawn a great deal of research interest. One of the main interests lies in assessing the contribution of discount rate and cash flow news to stock prices movement (See, for example, Campbell, 1991; Campbell & Mei, 1993; Campbell & Ammer, 1993; Vuolteenaho,

[1] Results are robust to reasonable variation in ρ.

2002; Cochrane, 2008; Campbell, Polk & Vuolteenaho, 2010; Cochrane, 2011; among many others). Campbell (1991) addressed this issue using US monthly data from 1927 and 1988. Lagged stock return, dividend-price ratio and relative bill rate are included in their VAR specifications to empirically model cash flow component and discount component. He found that variance in changing expected dividends, variance of changing expected returns and their covariance all share equal importance when explaining stock returns, with one-third for each other. However, discounted rates might have a greater effect due to their persistence. This idea is popular in many studies. For example, Campbell & Mei (1993) included market excess return, real interest rate, dividend yield on market portfolio and inflation rate and growth rate of industrial production as state variables in their VARs in order to decompose stock price beta into three components: cash flows, real interest rates and excess returns. It is suggested that the discounted rate beta outweighs the other two. A similar result is found by Campbell & Ammer (1993) using monthly postwar the US data, and by Vuolteenaho (2002) at aggregate level. More recently, Cochrane (2008) confirmed that, at aggregate level, stock returns were largely driven by discounted rate news instead of cash flow news. He emphasized the importance of discounted rates again in the recent Presidential Address in the Journal of Finance. (Cochrane, 2011) In VAR estimation, 15-year ex post returns, dividend growth and dividend yields are regarded as state variables, using annual data from 1947 to 2009. He attributed all price-dividend variation to discount-rate variation and questioned the implications by using the CAPM model. However, some researchers have also suggested that stock returns are attributed more to news about cash flows than to news about discounted rate (See, for example, Vuolteenaho, 2002; Callen & Segal, 2004; Larrain & Yogo, 2008; Bredin & Hyde, 2011; Bartram & Bodnar, 2012; Chen, Da & Zhao, 2013; among many others). For example, a firm's stock return was decomposed into cash flow components and discounted rate components by Vuolteenaho (2002). Stock returns, book-to-market ratio, GAAP ROE and leverage ratio are included in the state variable for VAR specification. Using annual data from 1954 and 1996, he found that the cash flow component dominates discounted rate news for movements in stock prices. In particular, the variance in cash flow news is found to be more than twice that of discounted rate news. However, this volatility in cash flow news can be largely diversified in aggregate portfolios. Even when using time-varying discounted rates in analysis, a similar result is obtained by Larrain & Yogo (2008). Net payout yield was employed in their research, to indicate the variation in long-run discounted rates. The results show that the cash flow component makes a greater impact than discounted rate news. Callen & Segal (2004) decomposed stock returns into three components: accruals, cash flows and discounted rates. In particular, net income was divided into cash flows and accrual earnings following Vuolteenaho's model. They found that both cash flows and accrual earnings drive stock returns to the same extent. But there is a lower effect from discounted rate news. Bredin & Hyde (2011) employed this methodology to investigate foreign exchange rate exposure for portfolios in the G7 at industry-level. The state variables included in their VAR are real stock market excess return, exchange rate changes and interest rate changes. The cash flow beta is found to be much larger than the discounted rate betas, indicating that stock return movements are more associated with cash flow news than discounted rate news. Bartram & Bodnar (2012) found consistent results as well. Cash flow effect is suggested to be more prominent than discounted rate effect for exchange rate exposure. This result is confirmed by Chen, Da & Zhao (2013). They found that the importance of cash flow news to stock returns increased as a result of a longer investment horizon, using direct cash flow forecasts. Especially for horizons over two years, the cash flows component becomes even more important, both at firm-level and aggregate-level.

There is a tendency in research to use this beta decomposition to explain the size and value effect (See, for example, Campbell and Vuolteenaho, 2004; Campbell, Polk & Vuolteenaho, 2010; Garrett & Priestley, 2012; among many others). Campbell and Vuolteenaho (2004) broke the asset beta into two components: "bad" cash flow beta and "good" discounted rate beta. This two-beta model was developed to explain the size and value effect in stock returns. Excess log return on the market, term yield spread, price-earnings ratio and small-stock value spread are specifically included in their VAR. The higher cash flow betas for value and small stocks offer an explanation. Several years later, Campbell, Polk & Vuolteenaho (2010) distinguished the role of cash flow component and discounted rate component at aggregate level and firm level respectively. In particular, a four-beta decomposition framework was developed in their study in order to study the driver of high betas of value stocks and growth stocks. Excess log return on the market, term yield spread, log smoothed price-earnings ratio and small-stock value spread are included in the aggregate VAR specification while log firm-level return, log book-to-market ratio and long-term profitability are included in firm-level VAR. Cash-flow fundamentals of firms are found to be related to high betas of growth stocks with the market's discounted rate news. However, Garrett & Priestley (2012) found that cash flow betas can explain size effect but not its relationship with value effect. In addition, Botshekan, Kraeussl & Lucas (2012) also developed a four-beta model to study cash flow component and discounted rate component in up and down market respectively. Three variables including log excess market return, three-month Treasury bill rates and dividend yield are used as state variables in their VAR specification. Using US data from between 1963 and 2008, they found that the largest premium is for downside cash flow betas and discounted rate betas.

Although the return decomposition framework was very successful, empirical applications by VAR, estimated for decomposing cash flow components and discounted rate components, have recently received much criticism (See, for example, Chen and Zhao, 2009; Chen, 2010; Garrett & Priestley, 2012; Chen, Da & Priestley, 2012; Engsted, et al., 2012; among many others). One of the most influential works was by Chen and Zhao (2009). They claimed that the finding of Campbell and Vuolteenaho (2004) was a special case, due to the methodology used for decomposition. In particular, whether measuring cash flows directly and backing out cash flow news or vice visa, use of it greatly changed the result. The reason is that it is difficult to have a “true model” for return predicting. Hence, they argued, the residuals used for cash flows news inherit misspecification errors. This result was again confirmed by Garrett & Priestley (2012). They compared two VARs using annual data. The first one followed Campbell and Vuolteenaho (2004) and employs term yield spread, 10-year price-earnings ratio, small-stock value spread and lagged returns as state variables. The second one followed Chen and Zhao (2009) and uses dividend growth, returns, estimated cointegrating vector between log real dividends, log real prices and log real earnings for the S&P 500 index as state variables. The result shows that discounted rate news dominates cash flow news if the cash flow component is backing out as residuals. However, cash flow news becomes more important than discounted rate news when measuring cash flow components directly. In addition, Chen (2010) also pointed out that the choice of state variables in the VAR specification changes the relative importance of cash flow and discounted rate innovations. The study suggests that dividend yield be included in the VAR), A further suggestion is that it is better to employ smoothed cash flows when comparing relative cash flow and discounted rate predictability (Chen, Da & Priestley (2012)). Engsted. et al. (2012) insist that asset price should be included in VAR models. If a properly specified VAR is found, there will be no difference between computing cash flow components and discounted rate component directly. A forthcoming paper by Kelly & Pruitt (2013) even develops a dynamic latent factor model and finds less persistent discount rates than previous research.

In summary, stock returns can be decomposed into two components: changes in cash flows and changes in discounted rates. However, there is no consensus on the relative importance of each component. Ever with the empirical VAR model used for decomposition, there is a debate about the computing methodology as well as the choice of state variables. This on-going question needs much more research.

2.6 Conclusion and promising research ideas

2.6.1 Conclusion

This chapter comprehensively and critically reviews the theoretical and empirical research on the relationship between exchange rates and stock prices. In particular, the relationship between them at both macro and micro level is carefully studied. In addition, at micro level, the interaction between exchange rates and stock prices is seen as foreign exchange exposure of stock prices. Therefore, studies on share valuation models as well as on stock return decomposition are also examined in this chapter. Although there is still much debate about the relationship between exchange rate and stock prices, some conclusions can be drawn from the existing research reviewed in this chapter.

Firstly, at macro level, the main debate about the interaction between exchange rates and stock prices lies in the Granger causality between them. There is no consensus in either theoretical or empirical studies. The theoretical framework suggests two different approaches: the traditional approach and the portfolio approach. While the traditional approach suggests that changes in stock prices result from exchange rates, the portfolio approach indicates that stock prices cause exchange rate movements. In empirical studies, relations that unidirectional from exchange rates to stock prices and unidirectional from stock prices to exchange rates, bidirectional relations, and existence of relation are found in different markets by using different estimation methods. In other words, Granger causality between exchange rates and stock prices leads to a mixed result. In summary, the relationship between exchange rates and stock prices at macro level is very sensitive to studied markets and estimation methods such as data frequency and, horizon.

Secondly, at micro level, the majority of research confirms that foreign exchange rates are priced in the stock price. That is to say, the interaction between exchange rates and stock prices means that the former predetermines the latter at micro level. However, a relatively low significance of foreign exposure to theory prediction has been widely found in empirical studies. This is sometimes called the “foreign exchange rate exposure puzzle” in research.

Thirdly, firm characteristics are recognized as important determinants of foreign exchange rate exposure by many researchers. The most widely used ones are size, foreign sales ratio and leverage. However, the effect of these firm characteristics on foreign exchange rate exposure is uncertain due to firms' hedging activities.

Furthermore, there are a number of share valuation approaches in accounting literature. Three valuation models including the Discounted Dividend model, the Free Cash Flow model and the Residual Income model are carefully studied in this chapter, in terms of both modeling equations and empirical evidence. Although each model has its own advantages and disadvantages, the Residual Income model is generally suggested to be superior to the other two models.

In addition, stock return decomposition has recently attracted a great deal of research interests. It is suggested that stock returns should be driven by two components: cash flow news and discounted rate news. However, there has not yet been a consensus about which one is the main driver of variations in stock returns

2.6.2 Promising research ideas

One of the most important purposes of reviewing research is to recognize research gaps and identify the promising research ideas. This section will summarise some of them, all of which are derived from the research in this chapter.

The first promising research idea relates to foreign exchange rate exposure. Studies haves clearly demonstrated that foreign exchange rate will affect stock price; this has been carried out both in theoretical studies and in empirical studies at micro level, and the process is sometimes called "foreign exchange rate exposure". However, there is no evidence of how and why this effect occurs. As exchange rate can enter into asset price by directly affecting the factors which can determine this price, we can model the channels through which this rate affects stock price, in order to offer more insights for investors, policy makers, regulators and researchers.

The second promising research idea relates to the role of firm characteristics in exchange rate pass-through effect. In particular, we are interested in investigating whether certain types of firms are affected by exchange rates through specified channels. In other words, the question is whether some channels only perform for particular types of company, and if this results in various currency exposures for different firms. Although research has clearly demonstrated that firm characteristics are important determinants of foreign exchange exposure, there is a lack of studies showing how and why this occurs. To address this gap, the effect of firm characteristics on pass-through channels should be examined, to provide insights about their impact on foreign exchange exposure. Characteristics such as size, leverage and openness, which are essential for cataloguing a firm identified by research, can be studied specially.

The third idea relates to the new methodology in stock return decomposition. There is currently a fashion for studying the main driver of unexpected stock return movements by variance decomposition. In particular, changes in stock returns have been found to be due to changes in cash flow news and discounted rate news. In finance theory, only unanticipated exchange rates have an impact on assets' price, since expected changes should already be priced. However, research usually employs "realized" changes in exchange rates to proxy unanticipated ones, and this might be misleading. Therefore, employing the return decomposition method to study the effect of unanticipated changes in exchange rates on stock prices would provide new evidence for the interaction between exchange rates and stock prices at micro level. Furthermore, it would also reveal which component is more largely affected by unexpected changes in exchange rates. The inside transmission channels can then be shown.

The fourth idea relates to the currency hedging activities. On the one hand, there is abundant research to suggest that they are used by firms to hedge foreign exchange risks. On the other hand, studies have found a relatively lower level of currency exposure than theory suggests. This difference is called "foreign exchange exposure". A large amount of research has related this currency exposure puzzle to hedging activities. However, there is no evidence to show which components of stock returns are most affected by these activities. In other words, it is interesting to investigate whether they perform the same with the cash flow component and discounted rate component, and whether there are some components that cannot be hedged.

The fifth research idea relates to Granger causality between exchange rates and stock prices at macro level. There are mixed results from both theoretical and empirical findings on this issue. Therefore, it would be helpful to re-examine this relationship during the financial crisis, and compare the new findings with ones found in previous crises, such as the Asian Financial Crisis of 1997.

In the rest of this thesis, I work on some of the new and promising research ideas derived from this literature review chapter. The first idea is investigated in Chapter 3 from a theoretical and model calibration perspective. This idea is examined again with empirical evidence in Chapter 4, and the second new research idea is also discussed further here. Chapter 5 deals with the third idea; it studies the effect of unanticipated changes in foreign exchange rates on stock return components. Concluding remarks are provided in Chapter 6.

CHAPTER 3

INTERROGATING THE ‘PASS-THROUGH’ EFFECT: THE TRANSMISSION CHANNELS OF EXCHANGE RATE FLUCTUATIONS INTO EQUITY PRICE

3.1 Introduction

With globalization and financial deregulation, international investment and portfolio diversification is enhanced at the same time as an increased volatility of foreign exchange rates. Therefore, the interaction between exchange rates and stock prices has been actively debated, as demonstrated by Carrieri et al (2006), Bartram (2007), Chue and Cook (2008), Kolari et al (2008), Choi and Jiang (2009), Muller and Verschoor (2009), Aggarwal and Harper (2010). The majority of the literature focuses on the exchange rates and stock price interaction directly in a bivariate sense at a macro level. At a micro level, researchers are interested in exposure of firms to fluctuations in exchange rates. However, there is no literature to offer insights into how the exchange rates affect the stock prices. In other words, as the existing literature has already discussed the question whether foreign exchange rate risk will be priced in stock price, there are no articles studying how do foreign exchange rates have an impact on stock prices. To this end, this chapter contributes to the literature by tracing the transmission channels through which the exchange rates affect the share price, and quantifying the relative importance of the different channels.

There is a long list of studies that examine the interaction between exchange rates and stock prices. Their main focus is to study the causality between these two variables. Although the previous studies tend to demonstrate the bidirectional causality between the exchange rates and stock prices, this study will focus on the effect of exchange rates on the stock price only, since there is abundant evidence to show that causality is predominantly running from exchange rates to stock prices on a micro level. For example, Granger et al (2000) found exchange rates cause stock price for South Korea by employing unit root and cointergration models. Early studies can be found in De and Gerard (1998), and Choi, et al. (1998). Recently, Carrieri et al (2006), Bartram (2007), Kolari et al (2008), and Chue & Cook (2008), all demonstrated that exchange rate risk will be priced using multi-factor asset pricing models. Moreover, Choi & Jiang (2009) and Aggarwal & Harper (2010) found significant evidence showing that even domestic companies will face significant currency exposure. In contrast, exchange rate is always seen as exogenous variable to stock price at micro level. In finance theory, investors of difference countries face different prices of goods in an international environment because of deviations from purchasing-power parity (PPP). In this sense, asset do contains foreign exchange risk premium in addition to the traditional premium based on the covariance with the market portfolio. (Dumas & Solink, 1995) That is to say, foreign exchange rate is related to aggregate factors and thus cannot be controlled from firm’s point of view. In theory, the main literature at micro level suggested that due to transaction exposure, economic exposure, translating exposure and exposure to imported substitutes, multinational corporations will face significant foreign exchange rate exposures. Even with domestic companies, foreign exchange rate fluctuations will affect the value of a company through import competition and operation exposure. However, there is no literature to show the transmission mechanisms through which the changes in exchange rates pass into stock prices. To this end, this study will address this gap.

Furthermore, the exchange rate pass-through into CPI or employment has been well studied in economic literature, such as Goldberg and Campa (2010), Nucci & Pozzolo (2010), Campa & Goldberg (2001). Following similar methodology in economic literature, we can develop a new model of exchange rate pass-through into stock prices, and employ this model to trace and quantify the transmission channels through which the changes in exchange rate pass into stock prices. To be specific, a set of new models of decomposing the exchange rate pass-through are set up based on three popular share valuation models in the accounting literature, including a discounted dividend model, a free cash flow model and a residual earnings model. Finally, cost of equity and cash flows or companies' earnings are recognized as potential channels of stock price responsiveness to exchange rates. Then, in order to make the new model operational, the parameters in the model are collected and obtained based on a sample of all UK non-financial firms which generate positive free cash flows and earnings. Earnings, cash flows from operation and cash investments are obtained from the firms' annual report through the Worldscope database, while the cost of equity is calculated by employing the IRR method suggested by Lee, Ng and Swaminathan (2009) and Chen, et al (2011). Furthermore, the panel regression with fixed effect is employed to calculate the sensitivities of each component. Finally, taking all these parameters into the model, the calibrated overall price sensitivity with respect to exchange rate is obtained. It is found that the earnings or cash flows can explain more than 85% of the final pass-through, while less than 15% can be explained by the cost of equity channel. In addition, alternative empirical models are also employed in order to provide robust findings.

This research contributes to existing literature in the following ways. Firstly, to the best of our knowledge, this study makes the first attempt at providing detailed evidence of how and why the exchange rates affect the stock prices, since there has already been already abundant literature to demonstrate the impact of exchange rates on stock prices. More importantly, by tracing and quantifying the transmission channels through which changes in exchange rates pass through into stock prices, an insight into the relation between exchange rates and stock prices can be produced. Secondly, this work bridges a gap between two common areas in accounting and finance: share valuation models in accounting literature, and foreign exchange rate exposure in the financial area. Specifically, this study begins with share valuation models, and employs the pass-through effect deviation in economic literature to analyse foreign exchange rate exposure in finance.

The remainder of the paper is organized as follows. Section 3.2 discusses the theoretical modelling for this study, and develops a new decomposing model for share values, which will be employed in the following analysis. Section 3.3 provides empirical methodology used to estimate the sensitivities of each component. The calibration of price elasticity with respect to exchange rates will be provided in Section 3.4, as well as the relative importance of each channel. Section 3.5 provides a robust check for the finding, using alternative empirical regression. Section 3.6 concludes this part.

3.2 Theoretical modelling

Although currency pass-through is well defined in the literature, there is no specific model for foreign exchange rate pass-through into stock prices. In this section, I will develop a new model in order to formalize the channels for exchange rate transmission into equity fair price, by starting with the measurement of currency pass-through in the literature. Then I will employ this definition in the share valuation models in the accounting literature to generate specific exchange rate pass-through into equity prices. Finally, the main predictions by this new set of models are discussed.

3.2.1 Model

The exchange rate pass-through literature suggests two main definitions. One defines the pass-through as the partial derivative of the stock price to the exchange rate, as demonstrated by Bartram, et al (2010). It can be measured by equation (3.1) as follows:

$$\eta^{p,x} = \frac{d \ln P_{it}}{d \ln X_{it}} \tag{3.1}$$

Where P_{it} is the stock price at time t for stock i, X_{it} is the exchange rate at time t for stock i, ln refers to the natural logarithms forms of these two variables and η is the currency pass-through. The other definition of pass-through advocates that price elasticities or pass-through rates can be derived from differentiation of stock price equation, with respect to exchange rate. (See, for example, Corsetti & Dedola, 2005; Goldberg & Campa, 2010; among many others) It can be measured by equation (3.2) as below:

$$\eta^{p,x} = \frac{dP_{it}}{dX_{it}} \frac{X_{it}}{P_{it}} \tag{3.2}$$

Where P_{it} is the stock price for equity i in valuation models at time t and X_{it} is the exchange rate faced by stock i at time t, this is the same as in equation (3.1). Since these two equations are mathematically the same, only the second measurement will be employed in this research, because of its simplicity. (Appendix 3.A)

In order to further formalize the transmission channels, the share valuation models are also studied in this section. In the theoretical aspect of share valuation literature, there are three main approaches. The first one is discounted cash flow valuation approach, which suggests that the value of stock is the present value of the expected cash flows discounted back at a rate that reflects the riskiness of these cash flows, based on the assumption of "going concern". The most widely used models in this approach are the Discounted Dividend model and the Discounted Cash Flow model. While the Discounted Dividend model uses dividends as expected income from equities, the free cash flow model employs free cash flows to the company instead. The second approach is the Liquidation and Accounting valuation approach. This approach is usually based on accrual accounting and assumes that there is significant information in the book value of a firm's assets and equity. The Residual Earnings model is the most popular one in this valuation approach. The third one is called relative valuation, which values the stock by looking at what the market is paying for similar assets. Multiples such as price-earnings ratio, price-to-book ratio, et al, are usually employed in the relative valuation approach. (Damodaran, 2005) In the empirical aspect, there are also abundant studies on the share pricing models. Among various valuation models, the Gordon Growth Model, the Free Cash Flow model and the Residual Earnings Model are the most widely used in empirical studies (See, for example, Jiang & Lee, 2007; Fama and French, 2008; Chen & Zhao, 2009; Campbell, Polk and Vuolteenaho, 2010; Chen and Zhao, 2009; among many others) For example, Fama and French (2008) employed this dividend discount model to investigate whether better estimates of stock returns can be provided by book-to-market ratio. Campbell, Polk and Vuolteenaho (2010) used discounted cash flow models to decompose the beta into beta for the expected cash flows and beta for the discounted rates. In addition, since there are no exact share price valuation equations in the third valuation approaches, and exchange rate pass-through literature suggests that there should be a valuation equation when developing the exchange rate elasticities models, the first two approaches including three models will be employed in this chapter, to study the transmission channels of exchange rate pass-through into stock prices.

To elaborate further on the transmission channels, we start with various stock valuation models, differentiate these models with respect to exchange rate, and finally obtain the overall elasticity of stock price to changes in foreign exchange.

3.2.1.1 Discounted Dividend Model

In accounting literature, the conventional discounted dividend model is fundamental. In this model, the stock price is calculated as the present value of the expected cash flows, discounted back at a rate that reflects the riskiness of these cash flows. Dividends are the cash flows that shareholders get from the firm. If the dividends are growing at a stable growth rate in the first period, the model collapses to the Gordon Growth Model. The constant growth model usually takes the following form:

$$V_t^e = \frac{D_{t+1}}{r_t - g} = \frac{Payoutratio * e(e_t : x_t)}{r(r_t : x_t) - g} \qquad (3.3)$$

Here, V_t^E is the value of equity at time t, D_{t+1} represents the dividends paid at time t+1, g refers to the dividend stable growth rate, r is the cost of capital and e is the companies' earnings. Research suggests that this model should work best for firms with a fixed pay-out ratio; therefore, the dividends can be seemed as earnings multiplied by pay-out ratio. Furthermore, r(.) and e(.) here indicates the variables are a function of foreign exchange rates. In particular, e (e_t: x_t) and r (r_t: x_t) stand for earnings and equity cost of capital respectively, which are both affected by exchange rates.

According to the literature, in this model, both earnings and cost of capital can be identified as transmission channels of exchange rate fluctuation. For earnings, when the exchange rate changes, the selling price of the products in foreign countries will also be changed as well as the price of labour, raw material and other inputs, and thus making the net income for a company change. Even for domestic companies, there are some inevitable imported inputs in this global environment, and they face competition by international firms as well. Therefore their earnings are significantly exposed to foreign exchange rate risks. In the terms of cost of equity, this will also be affected by foreign exchange risks. Cost of equity is a measure of required return for a company, and foreign exchange risk has already been demonstrated as a source of risks faced by companies. According to the basic financial concept that higher risk needs higher return, higher return should be required to compensate for the additional foreign exchange risk. Moreover, the international capital asset pricing model (International CAPM) suggests that the cost of equity will be affected by exchange rates. However, the pay-out ratio and stable growth rate are relatively constant when foreign exchange rate fluctuates, since they are more relevant to the firm's characteristics or macro economy than exchange rates. In summary, earnings and cost of capital are recognized as potential channels through which exchange rate fluctuations pass-through into stock prices. Therefore, exchange rate pass-through into stock price can be obtained by taking differentiation of stock price in equation (3.3), with respect to exchange rates. (Appendix 3.B1)

$$\eta^{p,x} = \frac{\partial P_{it}}{\partial X_{it}} * \frac{X_{it}}{P_{it}} = \eta^{e,x} - \eta^{r,x} * \frac{r_{it}(r_{it}:X_{it})}{r_{it}(r_{it}:X_{it}) - g} \tag{3.4}$$

$$\text{Where}\ \eta^{e,x} = \frac{\partial e_{it}}{\partial X_{it}} * \frac{X_{it}}{e_{it}} \quad , \quad \eta^{r,x} = \frac{\partial (r_{it} - g)}{\partial X_{it}} * \frac{X_{it}}{r_{it}} = \frac{\partial r_{it}}{\partial X_{it}} * \frac{X_{it}}{r_{it}} \tag{3.5}$$

Here, $\eta^{p,x}$ is stock price sensitivity to foreign exchange rates, $\eta^{e,x}$ is the exchange rate pass-through into company's earnings and $\eta^{r,x}$ is the elasticity of cost of equity with respect to exchange rates. All the other variables share the same definition in equation (3.3).

3.2.1.2 Free cash flow model

Another popular discounted cash flow valuation model is the free cash flow model. This model values the equity by deducting the value of debt from the firm's value. Compared with calculating the value of equity directly in the Dividend Discount model, this model considers both investing and operating activities for a company. In the free cash flow model, the value of equity can be written as:

$$V_t^e = V_t^f - V_t^d = \frac{CFO_t(CFO_t : X_t) - CI_t(CI_t : X_t)}{r_t(r_t : X_t) - g} - V_t^D \qquad (3.6)$$

Here, V_t^e, V_t^f, and V_t^d are the value of equity, the value of the firm and the book value of debt at time t respectively. CFO stands for cash flows from operations, which are cash inflows for a company, while CI refers to cash investments, which are cash outflows for a firm; r is the cost of capital, g refers to the stable growth rate and X_t is the exchange rates at time t. According to the accounting literature, it is very common to deduct only capital expenditure as cash investments, which is a common approximation in calculation. CFO_t (CFO_t: x_t), CI_t(CI_t: x_t), and r_t(r: x_t) refer to the cash flow from operations, cash investments and cost of capital for a firm, which will be affected by exchange rates.

The free cash flow model suggests that the cash flow from operations, cash investments and cost of capital for a firm should be recognized as potential channels through which exchange rate changes pass-through into stock prices. Similarly to discounted dividend models, exchange rates will have an impact on cost of equity and cash flows from operations. Empirical evidence can be found from earlier studies, such as Petersen & Thiagarajan (2000), Bartram (2007), Bartram (2008), among many others. For example, Bartram (2008) suggested significant foreign exchange rate exposure for operational cash flows, even the total cash flow might not be so exposed to foreign exchange rates due to hedging activities used by companies. In terms of cash investments, unexpected changes in exchange rates might have an impact on the cost of investments, as well as on the sources of investments such as earnings or operational cash flows, and then affect a company's cash investments. However, book value of debt will only be affected by firms' activities, such as repayment of debt, repurchase or issue shares, and not change when exchange rates fluctuate. Therefore, the changes in exchange rates pass-through into stock price can be obtained by differentiation of stock price with respect to exchange rate as follows: (Appendix 3. B2)

$$\eta^{p,x} = \frac{\partial P_{it}}{\partial X_{it}} * \frac{X_{it}}{P_{it}} = \eta^{cfo,x} * \frac{CFO_{it}(CFO_{it}:X_{it})}{CFO_{it}(CFO_{it}:X_{it}) - CI_{it}(CI_{it}:X_{it})} - \eta^{ci,x} * \frac{CI_{it}(CI_{it}:X_{it})}{CFO_{it}(CFO_{it}:X_{it}) - CI_{it}(CI_{it}:X_{it})} - \eta^{r,x} * \frac{r_{it}(r_{it}:X_{it})}{r_{it}(r_{it}:X_{it}) - g} \tag{3.7}$$

Where, $\eta^{r,x} = \frac{\partial(r_{it} - g)}{\partial X_{it}} * \frac{X_{it}}{r_{it}} = \frac{\partial r_{it}}{\partial X_{it}} * \frac{X_{it}}{r_{it}}$, $\eta^{cfo,x} = \frac{\partial CFO_{it}}{\partial X_{it}} * \frac{X_{it}}{CFO_{it}}$, and

$$\eta^{ci,x} = \frac{\partial CI_{it}}{\partial X_{it}} * \frac{X_{it}}{CI_{it}} \tag{3.8}$$

Here, $\eta^{cfo,x}$, $\eta^{ci,\ x}$ and $\eta^{r,\ x}$ are the elasticities of cash flow from operations, cash investments and equity cost of capital with regard to foreign exchange rates respectively, and $\eta^{p,\ x}$ is the overall stock price sensitivity to the foreign exchange rates. X_t is the foreign exchange rate at time t, and g refers to stable growth rate as above. CFO_{it} $(CFO_{it}:X_{it})$, $CI_{it}(CIit:X_{it})$ and $r(r_{it}:X_{it})$ are the cash flows from operation, cash investments and cost of capital for a company i during time t respectively, all of which are affected by foreign exchange rates.

3.2.1.3 Residual Earnings Model

Based on accrual accounting, the residual earnings model has attracted a great deal of interest. Compared to the Discounted Dividend model and the Discounted Free Cash Flow model, the residual earnings model focuses on profitability of investment, which drives the value of a firm. It shows that there is significant information on financial statements that it incorporates into the income statement and balance sheet rather than the cash flow statement, when valuing equity. If the residual earnings are assumed to be growing at a stable growth rate g at time t, the residual earnings model will take the following form:

$$V_t^e = B_t + \frac{RI_{t+1}}{r_t - g} \tag{3.9}$$

Here, V_t^e is the value of equity at time t, B_t is the book value of equity at time t, RI_{t+1} stands for the residual earnings during t to t+1, r_t is the equity cost of capital at time t, and g is the residual stable growth rate. This model suggests that the value of the equity is the sum of book value of equity at time t and all discounted value added by residual earnings in the future. Residual earnings are the “extra” earnings by the company, which is the rest of comprehensive earnings minus the previous book value, multiplied by required return on it. Therefore, the value of equity can be calculated from equation (3.10) as follows:

$$V_t^e = B_t + \frac{e_t - r_t * B_t}{r_t - g} = \frac{e_t - B_t * g}{r_t - g} = \frac{e_t(e_t : X_t) - B_t * g}{r_t(r_t : X_t) - g} \qquad (3.10)$$

Here, e_t (e_t:X_t) and r_t(r_t:X_t) refer to the comprehensive earnings for a firm during period t and the cost of equity respectively, both of which will be affected by foreign exchange rates, with all the other variables defined the same as in equation (3.9).

In the residual earnings model, the comprehensive earnings and cost of equity are recognized as potential channels through which changes in exchange rates pass-through into stock prices, which is the same as in the discounted dividend model. Moreover, both initial book value of equity and stable growth rate for residual earnings are related to the firm's characteristics and macro economy, and are assumed not to be affected by foreign exchange rates. Thus, according to the definition of exchange rate pass-through, the overall elasticities of stock price with respect to exchange rates can be calculated from equation (3.11):

$$\eta^{p,x} = \frac{\partial P_{it}}{\partial X_{it}} * \frac{X_{it}}{P_{it}} = \eta^{e,x} * \frac{e_{it}(e_{it} : X_{it})}{e_{it}(e_{it} : X_{it}) - B_{it} * g} - \eta^{r,x} * \frac{r_{it}(r_{it} : X_{it})}{r_{it}(r_{it} : X_{it}) - g} \qquad (3.11)$$

where $\eta^{e,x} = \frac{\partial e_{it}}{\partial X_{it}} * \frac{X_{it}}{e_{it}}$, $\eta^{r,x} = \frac{\partial r_{it}}{\partial X_{it}} * \frac{X_{it}}{r_{it}}$ (3.12)

Here $\eta^{e,x}$ and $\eta^{r,x}$ are earnings sensitivity and elasticity of equity cost of capital, with respect to foreign exchange rates for a firm, respectively. $e_{it}(e_{it}:X_{it})$ and $r_{it}(r_{it}:X_{it})$ refer to the comprehensive earnings for a firm i during period t and the cost of equity respectively, both of which will be affected by foreign exchange rates.

3.2.2 The propagation mechanism

The models which are developed above provide a number of testable insights into the mechanisms underlying the fair price of equity response to foreign exchange rate variations. Various channels are suggested by different share valuation models, which include the company's earnings, cost of equity, cash flows from operation, and cash investments. Company earnings and cash flow from operations are similarly affected by foreign exchange rates. They will respond to fluctuations in exchange rates due to their effect on product selling prices in foreign currency, imported inputs price and competition status. However, the direction of this impact cannot be ascertained due to a company's external orientation towards international markets. For example, while currency depreciation will decrease the selling price of products in foreign markets and thus increase the sales for an export-oriented company, it may also increase the price of imported inputs for an import-oriented firm and thus decrease its turnover. For cost of equity, higher foreign exchange risk requires higher return for compensation. In other words, if the changes in the foreign exchange rates grow, the cost of equity will increase to compensate for additional foreign exchange risks. In terms of cash investments, foreign exchange rates will have an impact on cash flow from operations and the investment price dominated in home currency, and thus affecting the cash investments for a company.

In equation (3.4), the discounted dividend model shows that the stock price is sensitive to foreign exchange rates because of cost of equity, which is the only channel for stock price sensitivity to exchange rates. The cost of equity channel should be seen as a positive channel, if this cost of equity increases as a result of currency appreciation, as captured by $\eta^{r,x} > 0$[2]. However, if the cost of capital is negatively affected by foreign exchange risks, as captured by $\eta^{r,x} < 0$, it will be a negative transmission channel for the responsiveness of stock prices to exchange rates. Furthermore, the magnitude of the effect of the channel depends on the cost of equity's response to exchange rates.

Based on the discounted cash flow model, equation (3.7) indicates that the changes in exchange rate pass-through into stock price can be decomposed into elasticities of cash flow from operations, cash investments and cost of capital for a firm, with

2 $\eta^{\rho,x} = \eta^{e,x} - \eta^{r,x} * \frac{r(r_t : X_t)}{r(r_t : X_t) - g} = \eta^{e,x} - \eta^{r,x} * \frac{1}{1 - \frac{g}{r(r_t : X_t)}}$

respect to exchange rates. As opposed to results based on the discounted dividend model, this decomposing offers three potential channels through which changes in exchange rates pass-through into stock prices. Similarly to the indication in the discounted dividend model, cost of equity is also a positive channel only if $\eta^{r,x} > 0$, and it is a negative one when $\eta^{r,x} < 0$. [3] Moreover, if the cash flows from operation are less sensitive to foreign exchange rates than cash investments, as captured by $\eta^{cfo,x} < \eta^{ci,x}$, cash flows from operations will be a negative channel through which changes in foreign exchange rates pass-through into stock prices. However, cash investments will function as a positive channel to pass-through changes in foreign exchange rates into share prices. In addition, the magnitude of effects of both these two channels depends on the relative flexibility of cash flows from operations, compared to cash investments when foreign exchange rates fluctuate.

In equation (3.11), the Residual Earnings model suggested that stock prices should respond to exchange rates through two channels: company earnings or cost of capital. Cost of capital plays the same role, as suggested by the discounted dividend model

---

3

$$\eta^{\rho,x} = \eta^{cfo,x} * \frac{CFO(CFO_t : X_t)}{CFO(CFO_t : X_t) - CI(CI_t : X_t)} - \eta^{ci,x} * \frac{CI(CI_t : X_t)}{CFO(CFO_t : X_t) - CI(CI_t : X_t)} - \eta^{r,x} * \frac{r(r_t : X_t)}{r(r_t : X_t) - g} = \eta^{cfo,x} - (\eta^{cfo,x} - \eta^{ci,x}) * \frac{1}{\frac{CFO(CFO_t : X_t)}{CI(CI_t : X_t)} - 1} - \eta^{r,x} * \frac{1}{1 - \frac{g}{r(r_t : X)}}$$

and the free cash flow model. However, the residual earnings model also shows a negative channel for a company's earnings if they are positively related to exchange rates as captured by $\eta^{e,x}>0$.[4] In other words, company earnings will damp the stock price sensitivity to exchange rates, with the magnitude of this damping dependent on whether the earnings respond to exchange rates, and if company's earnings are positively related to exchange rates or not.

In conclusion, based on the three different valuation models in accounting literature, three different decomposing methods have been found by using the definition of exchange rate pass-through. Based on the discounted dividend model, only cost of equity is recognized as a channel through which changes in foreign exchange rates pass-through into stock prices. Moreover, if cost of equity is positively related to foreign exchange rates, as captured by $\eta^{r,x}>0$, it will be a positive channel through which foreign exchange rate fluctuations can be transmitted into share fair price. However, the Residual Earnings model suggests adding one more channel—the company's earnings. Besides the positive channel as cost of equity performs when $\eta^{r,x}>0$, company earnings should be a negative channel if $\eta^{e,x}>0$. That is to say,

4

$$\eta^{\rho,x} = \eta^{e,x} * \frac{e_t(e_t : X_t)}{e_t(e_t : X_t) - B * g} - \eta^{r,x} * \frac{r(r_t : X_t)}{r(r_t : X_t) - g} = \eta^{e,x} * \frac{1}{1 - \frac{B * g}{e_t(e_t : X_t)}} - \eta^{r,x} * \frac{1}{1 - \frac{g}{r(r_t : X_t)}}$$

company earnings will damp the effect of foreign exchange rates on share prices, with the magnitude of this damping dependent on how company earnings are affected by foreign exchange rates, if they are affected in a positive way. However, the Free Cash Flow model suggests three potential channels through which exchange rates pass-through into stock prices: elasticity of cash flow from operations, elasticity of cash investments and elasticity of cost of capital for a firm, with respect to exchange rates. Moreover, cost of equity and cash investments will both perform as positive channels if $\eta^{r,x} > 0$ and $\eta^{cfo,x} < \eta^{ci,x}$, and cash flow from operations will be a negative channel, which is similar to the effect of earnings suggested by the Residual Earnings model when $\eta^{e,x} > 0$. To summarise, if each component is positively related to exchange rates, and the cash flow from operations is less sensitive to exchange rates than cash investments, the company's earnings or cash flow from operations should damp the effect of foreign exchange rates on stock prices, and cost of equity will put mounting pressure on final stock prices to the extent that cost of equity can respond to foreign exchange rates by itself. This might explain why low levels of significant foreign exchange exposure have been found in the majority of research when using stock prices rather than cash flow. This indication is consistent with previous research, which explains the cross-sectional variation in stock price by cash flow and discounted rates effects. (See, for example, Bredin & Hyde, 2011; Chen & Zhao, 2009; Campbell, Polk & Vuolteenaho, 2010; among many others)

3.3 Empirical modelling

Aggregated equations (3.4), (3.7) and (3.11) provide the necessary decomposing components for calibrating stock price sensitivity to exchange rates, based on the discounted dividend model, free cash flow model, and residual earnings model respectively. In this section, empirical evidence for these parameters in each equation will be provided.

3.3.1 Empirical model of sensitivities of each component with regard to exchange rates

According to identified channels based on the discounted dividend model, discounted free cash flow model and residual earning model respectively, changes in exchange rates might pass-through into stock prices through an earnings channel, cost of equity channel, cash flow from operations channel or cash investments channel. Therefore, this section will provide empirical evidence for the sensitivity of each channel.

For each channel's sensitivity, the simple panel regression of every component of the exchange rates is employed respectively, in order to provide the overall elasticities of exchange rates to each channel. In addition, for every model, we control the differences in the cost of equity, earnings, cash flow from operations and cash investments across companies broadly, by means of firm fixed effects. Moreover, these differences are also controlled across time by including year fixed effects. The specific model for each channel can be summarised as follows.

Firstly, in terms of the cost of equity channel, there is abundant literature on its sensitivity with respect to exchange rates. Following the model suggested by many researchers, such as Doidge, Griffin & Williamson, 2006; Francis, Hasan & Hunter, 2008; Lee, et al 2009; Choi & Jiang, 2009; Aggarwal & Harper, 2010; among many others, the equation (3.13) will be employed to estimate the total elasticity of cost of equity to exchange rates. A combination of firm and time fixed effects is introduced. The models take the following form:

$$\Delta r_t^i = \alpha_t + \alpha_i + \eta^{r,x} \Delta x_t + \varepsilon_{it} \tag{3.13}$$

Where, r_t is the cost of equity for a firm over time period t, x is the normal exchange rates or real exchange rates, and α_i and α_t refer to the firm's fixed effect and time effect respectively. The lower case means the logarithm forms of the variables, and Δ refers to the first differences of the variables. The coefficient $\eta^{r,x}$ measures the firm's overall sensitivity of cost of capital, with regard to the market's foreign exchange rates. Equation (3.13) will be employed to obtain the sensitivity of cost of equity with respect to foreign exchange rates $\eta^{r,x}$ in the theoretical framework.

For elasticity of earnings with respect to exchange rates, the literature suggests this can be measured by equation (3.14) as follows (Bartram, 2007, 2008):

$$\Delta e_t^i = \alpha_t + \alpha_i + \eta^{e,x} \Delta x_t + \varepsilon_t \tag{3.14}$$

Here, e_t is the companies' earnings in period t, x_t is the foreign exchange rates, and α_i and α_t refer to the firm's fixed effect and time effect respectively. All the lower case figures also refer to the logarithm's forms of variables, and Δ refers to the first differences of the variables. The coefficient $\eta^{e,x}$ is the total exposure of companies' earnings with respect to foreign exchange rates. Thus, equation (3.14) will be employed to obtain the sensitivity of companies' earnings to exchange rates $\eta^{e,x}$ in the theoretical modelling.

Moreover, the effect of foreign exchange risk on cash flow from operations is similar to the impact of companies' earnings. The following equation is suggested by research, to measure cash flow exposure with respect to exchange rates (Bartram, 2007, 2008):

$$\Delta cfo_t^i = \alpha_i + \alpha_t + \eta^{cfo,x} \Delta x_t + \varepsilon_t \tag{3.15}$$

cfo is cash flow from operations during period t, x is also defined as foreign exchange rates, and α_i and α_t refer to the firm's fixed effect and time effect respectively. All the lower case figures also refer to the logarithm's forms of variables, and Δ refers to the first differences in the variables. The coefficient $\eta^{cfo,x}$ refers to the total elasticity of cash flow from operations with respect to exchange rates. Thus, equation (3.15) can be used to estimate the sensitivity of cash flows from operations with respect to foreign exchange rates $\eta^{cfo,x}$ in the theoretical model above.

In addition, in terms of cash investment, the following equation will be used to obtain the total sensitivity of cash investment with respect to exchange rates.

$$\Delta ci_t^i = \alpha_i + \alpha_t + \eta^{ci,x} \Delta x_t + \varepsilon_t \quad (3.16)$$

Where, ci is the cash investments during period t for a company, and x is also defined as foreign exchange rates, and α_i and α_t refer to the firm fixed effect and time effect respectively as above. All the lowercase also refers to the logarithms forms of variables and Δ refers to the first differences of the variables. The coefficient $\eta^{ci,x}$ measures the total exposure of cash investment to foreign exchange rates. Thus, equation (3.16) can be employed to obtained the elasticity of cash investments with respect to exchange rates $\eta^{ci,x}$ needed in the theoretical framework.

There is limitation of these measurements of foreign exchange sensitivities. Since research suggested that firms exposed to foreign rate risk do hedge their exposures, these measurements ignore the hedging activities in this study. It is mainly due to the data unavailability. In particular, it is not standard requirement for reporting foreign exchange hedging activities according to GAAP. Therefore, the data for hedging activities needs hand collecting. More importantly, even using hand-collected hedging data, there might experience significant selection bias due to the firms' choice between report the hedging activities or not. Generally speaking, this research is interested in transmissions channels through which exchange rates affect stock prices. Although hedging activities will have an impact on foreign exchange exposure, the transmissions channels are not changed by hedging activities. However, the relative importance of each transmission channels might be related to hedging activities. Literature suggested that hedging should reduce a firm's tax liability. In other words, hedging costs can reduce a firm's profits and its cash flows. Thus, these hedging activities reduce the relative importance of revenue channel. In our analysis, all the results are based on reported cash flows or earnings, in which hedging activities have been already impounded if there is any. Therefore, this study will underestimate the importance via cash flow channel for firms with significant hedging activities. However, this will not alter the final conclusion that cash flow beta outweighs discounted rate beta.

3.3.2 Empirical variables in the model

After estimating all the elasticities of identified channels suggested by the theoretical model, all measurements of inputs parameters can be listed in Table 3.1, in order to make the decomposing pass-through operational.

For the sensitivity of cost of capital, cash flow from operations, cash investments and earnings, with respect to exchange rate, it is suggested that simple linear regression can be employed to calculate these sensitivities, as equation (3.13), (3.14), (3.15) and (3.16) show in the previous section. In specific, each variable is regressed on the foreign exchange rates to obtain the overall sensitivity of each element to the exchange rates.

In terms of cash flow from operations and earnings, the exchange rate will affect the selling price of products in foreign markets and the price of imported inputs, thus having an impact on these two variables. These two variables are measured by the cash flows from operations in the cash flow statement and the net income in the income statement, and collected from Worldscope via Thomas one banker analytics.

For cash investments, the foreign exchange will have an impact on their price and on the funding available for investment, as well as on its profitability, thereby affecting these investments. In empirical studies, capital expenditures, which are used to purchase fixed assets such as equipment, buildings and so on, are a good proxy of cash investment as suggested by Penman (2010). This can be obtained from Worldscope via Thomas one banker analytics.

Cost of capital will be affected by foreign exchange rates due to investment opportunities. Research suggests that the implied approach provides a less volatile estimation of expected returns. Hence, the cost of capital is calculated by employing implied cost of capital in this research. (See, for example, Ohlson & Juettner-Nauroth, 2005; Claus and Thomas, 2001; Lee, Ng and Swaminathan, 2009; among many others) Furthermore, a single-period with stable growth model is employed in this analysis instead of the infinite model used in Lee, Ng and Swaminathan (2009), which is consistent with the theoretical model used in this study. More specifically, this study computes the main measure of cost of equity capital for each firm as the internal rate of return that balances the present value of future dividends with current stock prices, as suggested by equation (3.3). It is found that the required return was about 8.88% between 1990 and 2011 in this study, which is consistent with the findings in Lee, Ng and Swaminathan (2009).[5]

For exchange rates, since every firm may face various foreign exchange rate risks, a trade-weighted exchange rate is employed in the literature in question. (See, for example, Bartram, 2007; Chue and Cook, 2008; among many others) In this study, the trade-weighted exchange rate board calculated by Bank of England is used, and it is a

[5] Lee, Ng and Swaminathan (2009) found implied risk premium, which equals to rate of return subtract the yield on a 10-year U.S. government bond, is around 5.4% for UK between 1991 and 2000.

"measure of the overall change in the trade-weighted exchange value of sterling, calculated by weighting together bilateral exchange rates", where a lower index indicates sterling depreciation (Bank of England). This data is obtained from the Bank of England's official website.

In terms of stable growth rate, it is assumed that in a company it will revert to the long-established nominal world gross domestic product (GDP) growth rate. (Lee, Ng and Swaminathan (2009) In other words, stable growth rate can be calculated by adding the world average real GDP growth rate over the last 10 years to the UK inflation rate over the same period. The data for world average real GDP is collected from International Monetary Fund statistics, and the data for UK inflation is obtained from the Datastream database.

Table 3.1: Description of the main variables used in Chapter 3

Variables	Measurement	Empirical counterpart	Sources
Cost of capital (r)	Implied cost of capital (IRR) according to equation (3.3) (Lee, Ng and Swaminathan, 2009)	Stock price	Worldscope
		The number of share outstanding	Worldscope
		Cash dividends	Worldscope
		Stable growth rate[6]	
Stable growth rate (g)	Sum of the average world real GDP growth rate plus UK inflation (Lee, Ng and Swaminathan, 2009)	World real GDP growth	International Monetary Fund statistics
		UK inflation	Datastream
Cash flow from operations (CFO)	Reported cash flow from operations in financial statements	Cash flow from operations	Worldscope
Cash investments (CI)	Capital expenditure (Penman, 2010)	Cash expenditure	Worldscope
Book value of equity (B)	Reported value of equity in financial statements	Value of equity	Worldscope
Earnings (e)	Net income (Lee, Ng and Swaminathan, 2009)	Net income	Worldscope
Sensitivity of cost of equity to exchange rate (	International CAPM (Aggarwal & Harper, 2010, et al) (equation 3.13)	Cost of equity[7]	Equation (3.3)
		Trade-weighted exchange rate	Bank of England

[6] See stable growth rate in the next row

[7] See cost of equity in above.

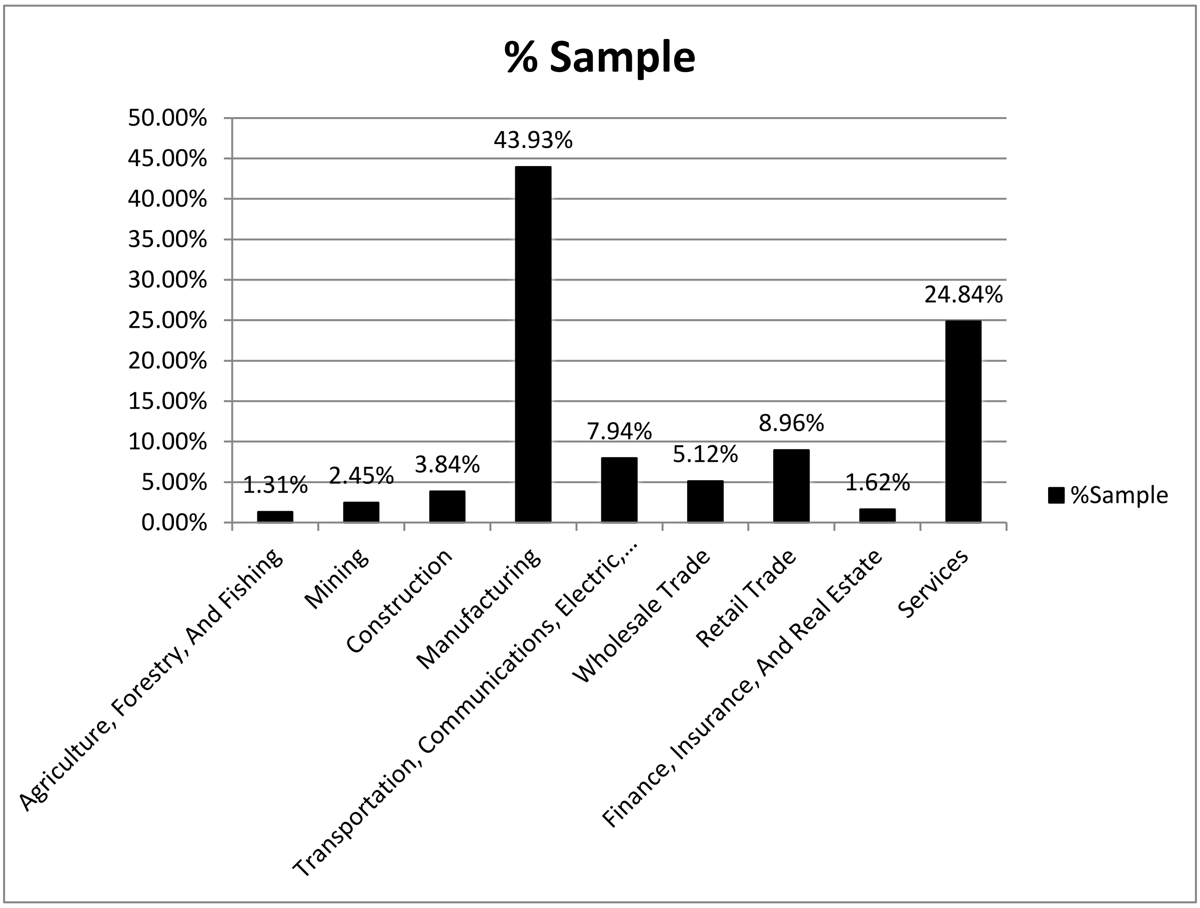
$\eta^{r,x}$)			
Sensitivity of earnings to exchange rate ($\eta^{e,x}$)	Simple linear regression model (Bartram, 2007, 2008) (equation 3.14)	Net income	Worldscope
		Trade-weighted exchange rate	Bank of England
Sensitivity of cash flow from operations to exchange rate ($\eta^{cfo,x}$)	Simple linear regression model (Bartram, 2007, 2008) (equation 3.15)	Cash flow from operations	Worldscope
		Trade-weighted exchange rate	Bank of England
Sensitivity of cash investments to exchange rate ($\eta^{ci,x}$)	Simple linear regression model (Bartram, 2007, 2008) (equation 3.16)	Cash investments	Worldscope
		Trade-weighted exchange rate	Bank of England

3.3.3 Sample selection

Our sample of UK nonfinancial firms is taken from the Worldscope database. The financial industry is not included in the sample due to its different accounting method as well as the different foreign risks it faces. Since the trade-weighted exchange rate sterling calculated by the Bank of England is from 1990, we will focus our analysis on the period 1990-2011. Since the study here requires the accounting data from companies, we confine our analysis to an annual basis due to the data limitations. For the firm-level data, we require the availability of the following items: common dividends, fiscal year end stock prices, book value of equity, book value of debt, common shares outstanding at the end of fiscal year, cash flow from operations, capital expenditures and net income. In addition, industry classification SIC is also obtained from the worldscope database. Specifically, following the similar screening procedure suggested by Lee, Ng and Swaminathan (2009), the following steps are employed to generate the final sample used in this study. Firstly, firms with negative common equity are excluded. Next, due to the assumption made in the discounted dividend model, free cash flow model and residual earnings model, firms whose free cash flows or net income are negative or unavailable are excluded. In addition, only companies with a record of more than five years are included in the sample due to continuing rules in accounting method and assumption of stable growth in share valuation models. To avoid survivor bias, an unbalanced panel data of firm-level consisting of 3515 observations for 421 nonfinancial companies, is finally formed for this research.

In order to show some differences between industries, we employ 2-digit SIC codes to collect industries into 9 major SIC divisions A-J, following the example of Kahle and Walking (1996). Figure 3.1 clearly shows the industry decomposition in our final sample. It can be seen that more than 40% of the sample comes from the manufacturing industry, which means that the result might be heavily influenced by this type of industry. Furthermore, about one quarter of the firms are part of the service industry, while the remaining seven industries only account for around one third of the sample. In addition, since the financial industry is not included in the sample, only 1.62% of the sample comes from the financial, insurance and real estate industries. Actually, the real estate is the main in this industry for our sample. Overall, this sample distribution is consistent with the actual economy in the UK, where today the majority of firms are part of the manufacturing and service sectors, and it can usefully represent the UK economy.

Figure 3.1: Industry Decomposition



Notes: The % Sample stands for the observations within that industry as a percentage of the overall observations in the whole sample between 1990 and 2011. (Appendix 3.C)

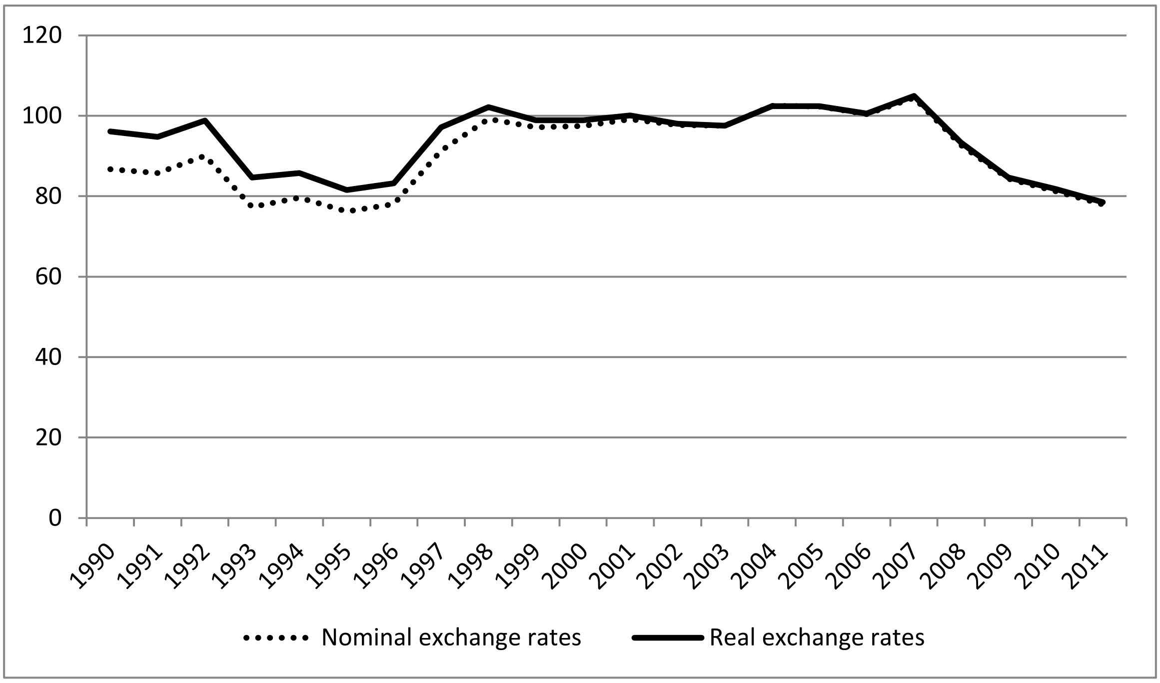
3.4 Evidence from transmission channels

In order to make the theoretical framework in Section 3.2 operational, this section provides rich data for the main variables used in the theoretical framework including trade-weighted exchange rates, companies' net income, cost of equity, cash flows from operations and cash investments. Given the extensive data across industries for these main variables, this section will offer more evidence of the sensitivities of each element to exchange rates.

3.4.1 Data Description of main variables

Figure 3.2 clearly shows the trends in nominal and real trade-weighted exchange rates for sterling between 1990 and 2011. It can be seen that the real exchange rate is slightly higher than the nominal exchange rate due to negative inflation before 2002. However, between 2002 and 2011, there is little difference between nominal trade-weighted exchange rates for sterling, and actual ones. Figure 3.2 indicates a relatively stable foreign exchange rate between late 1998 and early 2007, when after the Asian financial crisis in 1997 and before today's financial crisis began in 2008. Table 3.2 summarizes the main descriptive statistics for exchange rates during 1990 and 2011. Panel A shows descriptive statistics for the raw data, and Panel B presents the statistics for the logarithm forms of the variables. Generally speaking, the nominal exchange rate is more volatile than the actual ones, as indicated by a higher standard deviation. Furthermore, the exchange rates exhibit an average value of 94 for nominal rates and 95 for real ones respectively. In addition, the distribution of both the nominal exchange rates and real ones are much closer to nominal distribution after taking logarithms of these two variables.

Figure 3.2 Time series plot of trade-weighted exchange rate for sterling



Notes: The data is obtained from the Bank of England.

Table 3.2: Descriptive statistics for trade-weighted exchange rates

Variable	Mean	Std. Dev.	25th percentile	50th percentile	75th percentile	Skewness	Kurtosis	Obs.
Panel A: Descriptive statistics for original variables								
X1	94.0489	8.7835	84.31	97.51	100.43	-0.7404	2.1360	3515
X2	95.3991	7.9475	85.7685	97.9911	102.1707	-0.7409	2.0145	3515
Panel B: Descriptive statistics for logarithms form of variables								
X1	4.5392	0.0973	4.4345	4.5780	4.6095	-0.8249	2.2548	3515
X2	4.5544	0.0863	4.4517	4.5849	4.6266	-0.7985	2.0695	3515

Notes:

1. X1 and X2 refer to nominal trade-weighted exchange rate and real trade-weighted exchange rates for sterling respectively.
2. The data is collected from the Bank of England for the period 1990-2011.

Table 3.3, 3.4, 3.5 and 3.6 present the descriptive statistics for each recognized channel. For companies’ earnings, Panel A in Table 3.4 shows that the mean and median net incomes in our sample are about 140 million pounds and 9.66 million pounds respectively. The distribution of companies’ net income is significantly skewed to the right, as the average net income is much higher than the median value. Also, distribution is quite dispersed, as the standard deviation suggests. When using log transformation of the variables, the volatility is reduced greatly, indicated by the lower standard deviation of around 2.25. The distributions are also almost normal , since the skewness is around zero and kurtosis is around three. In addition, there is a huge difference in firms' earnings across the industries. For example, while earnings from the mining industry and the agricultural, forestry and fishing industries are as high as over 900 million pounds, the service industry only has a net income of around 28 million pounds. In addition, there is a very low income in the finance, insurance, and real estate industries since the majority of financial firms are excluded from this study.

Tables 3.4 and Table 3.5 show descriptive statistics for cash flows from operations and cash investments respectively. While Panel A presents the summaries of the original data, Panel B shows descriptive statistics for the log forms of the variables. It can be seen from Table 3.4 that the cash flows from operations are higher than the net income for every industry, with an average value of 221 million pounds. Furthermore, the same pattern as that in companies' earnings among industries is found for cash flows from operations. In terms of cash investments, generally speaking, firms will invest more if there are more funds available. However, an industry with higher cash flows from operations or earnings does not always make higher cash investments. For example, there are many more cash flows from operations for the construction industry than for the service and wholesale trade industries, but the former has a lower level of cash investments than the latter. Similarly to net income, the distributions of companies' operational cash flows and cash investments are significantly positively skewed, indicated by much higher means than their median values across the industries. After taking log forms of the variables, Panel B shows that the distribution is much closer to normal distribution, and can later be employed to obtain the sensitivities of each channel.

Table 3.6 shows summaries of companies' cost of equity. These are very different from the cash flows, earnings and cash investments. All the industry share similar cost of equity, which is around 8.88%. The highest cost of equity is required by the wholesale trade industry (9.8%), while the service industry requires the lowest (8.12%). The standard deviation for all industries is around 0.025, indicating a less volatile cost of capital as Lee, Ng and Swaminathan (2009) suggests.

Table 3.7 presents the correlation matrix for the recognized channels and exchange rates. It can be seen from this table that cash flows from operations, cash investments, and net income are significantly positively correlated. This is consistent with research and what we found in the descriptive statistics above. Furthermore, the nominal exchange rate is also highly positively related to the real ones, as expected. However, there is little evidence for the relation between exchange rates and channels.

Table 3.3: Descriptive statistics for companies' earnings

Industry	Mean	Std. Dev.	25th percentile	50th percentile	75th percentile	Skewness	Kurtosis
Panel A: Descriptive statistics for original variables (unit: million)							
1	902	1060	31.2	539	1190	1.3646	4.0972
2	934	1910	7.43	116	751	2.7950	10.4093
3	56.7	77.8	7.2	23.1	74.1	2.1429	7.5526
4	152	558	2.22	8.39	44	5.9888	43.8953
5	272	918	6.13	22.6	116	6.5429	52.4866
6	41.2	79.7	2.85	8.12	45	3.6737	19.3124
7	62.8	102	4.56	19.9	77	2.7651	11.8051
8	8.63	14.3	0.25	1.89	9.84	2.0759	6.4439
9	28.5	62.4	1.37	4.78	21.2	4.3178	27.5021
Total	140	581	2.44	9.66	48.1	8.3457	90.9620
Panel B: Descriptive statistics for logarithms form of variables							
1	19.2916	2.3192	17.2559	20.1041	20.9008	-1.0870	3.9421
2	18.2048	2.8768	15.8210	18.5681	20.4369	-0.3808	2.4566
3	16.9546	1.4438	15.7896	16.9553	18.1209	-0.0666	2.2891
4	16.1751	2.2973	14.6137	15.9420	17.5987	0.2345	3.2003
5	17.1806	2.1075	15.6281	16.9324	18.5717	0.3833	2.6054
6	16.0542	1.9403	14.8630	15.9095	17.6216	-0.2943	3.1709
7	16.6802	1.8732	15.33261	16.8066	18.1593	-0.6087	4.0084
8	14.3099	2.1832	12.4417	14.4494	16.1022	-0.1823	2.0453
9	15.5042	1.9684	14.1281	15.3804	16.8673	-0.0396	2.8226
Total	16.2175	2.2543	14.7063	16.0836	17.6891	0.1398	3.1605

Notes:

1. The data is collected from Worldscope via Thomas one banker for the period 1990 -2011, with 421 firms consisting 3515 firm-year observations.
2. 1-9 indicate the different industry sectors as follows: 1. Agriculture, Forestry and Fishing 2. Mining 3. Construction 4. Manufacturing 5. Transportation, Communications, Electric, Gas, and Sanitary Services 6. Wholesale Trade 7. Retail Trade 8. Finance, Insurance, and Real Estate 9. Services

Table 3.4: Descriptive statistics for companies' cash flow from operations

Industry	Mean	Std. Dev.	25th percentile	50th percentile	75th percentile	Skewness	Kurtosis
Panel A: Descriptive statistics for original variables (unit: million)							
1	1380	1500	57.2	826	2410	0.9951	2.8334
2	1440	2760	16	267	1440	2.5304	8.7765
3	65.9	84.9	11.3	32.8	88.7	2.8684	14.4272
4	222	741	4.03	16.2	74	5.6083	39.8496
5	535	1690	11.5	49.5	232	5.4923	37.0280
6	61.5	138	4	13.3	59.8	4.7363	29.5302
7	103	155	9.03	36.2	149	2.7364	12.4582
8	10.7	16.9	0.22	4.27	9.89	2.0474	6.0944
9	50	116	2.46	8.55	38.7	5.1584	39.0214
Total	221	872	4.28	17	84.8	8.2491	90.8808
Panel B: Descriptive statistics for logarithms form of variables							
1	19.8963	2.0165	17.8627	20.5283	21.6022	-0.6844	2.2021
2	18.8927	2.6169	16.5866	19.4016	21.0873	-0.2281	2.2101
3	17.3237	1.2197	16.2396	17.306	18.3008	-0.0109	2.2579
4	16.7911	2.1780	15.2103	16.5976	18.1197	0.3565	2.8515
5	17.8486	2.1729	16.2539	17.7172	19.2640	0.2506	2.5151
6	16.5147	1.7481	15.2016	16.4006	17.9041	0.1529	2.3468
7	17.3217	1.6936	16.0163	17.4045	18.8195	-0.1813	2.1373
8	14.5992	2.3247	12.3089	15.2669	16.1068	-0.6018	2.4420
9	16.1081	1.8928	14.7157	15.9618	17.4725	0.1130	2.4880
Total	16.8158	2.1621	15.2702	16.6501	18.2558	0.2488	2.9445

Notes:

1. The data is collected from Worldscope via Thomas one banker for the period 1990 -001, with 421 firms consisting 3515 firm-year observations.
2. 1-9 indicate the different industry sectors as follows: 1. Agriculture, Forestry, And Fishing 2. Mining 3. Construction 4. Manufacturing 5. Transportation, Communications, Electric, Gas, and Sanitary Services 6. Wholesale Trade 7. Retail Trade 8. Finance, Insurance, and Real Estate 9. Services

Table 3.5: Descriptive statistics for companies' cash investments

Industry	Mean	Std. Dev.	25th percentile	50th percentile	75th percentile	Skewness	Kurtosis
Panel A: Descriptive statistics for original variables							
1	775	983	38.7	312	1240	1.4481	4.2687
2	690	1380	7.12	69.1	602	2.7407	10.716
3	8.86	11.1	1.63	5.35	11.4	2.4734	10.4453
4	56.5	167	1.04	4.35	26.2	5.0810	32.7793
5	255	773	2.70	17.2	92	4.1538	20.5665
6	20	47.2	0.57	3.44	19	4.6283	27.6641
7	45.1	80.8	3.18	11.9	50.1	3.7157	21.4685
8	3.25	7.50	0.0005	0.38	1.15	3.2051	13.3612
9	13.9	34.1	0.42	1.55	8.71	4.4717	28.2623
Total	80.9	372	0.894	4.46	27	9.5966	119.004
Panel B: Descriptive statistics for logarithms form of variables							
1	19.0492	2.2623	17.4710	19.5546	20.9394	-0.6324	2.2298
2	17.9497	2.7933	15.7784	18.0505	20.2166	-0.4939	3.6330
3	15.2765	1.3153	14.3035	15.4919	16.2478	-0.2848	2.4480
4	15.4876	2.3232	13.8595	15.3048	17.0964	0.0942	2.6522
5	16.5653	2.6664	14.8953	16.6619	18.3373	-0.0424	2.4343
6	14.9781	2.1686	13.2534	15.0504	16.7585	-0.1116	2.3592
7	16.3224	1.8192	14.9715	16.2935	17.7295	-0.2453	2.5229
8	12.9347	2.9905	11.3504	13.3847	14.9702	-0.8612	3.4355
9	14.4592	2.1417	12.9528	14.2525	15.9796	0.0940	2.5230
Total	15.43191	2.42601	13.73104	15.32491	17.1255	0.0913	2.9622

Notes:

1. The data is collected from Worldscope via Thomas one banker for the period 1990 -20011, with 421 firms consisting 3515 firm-year observations.
2. 1-9 indicate the different industry sectors as follows: 1. Agriculture, Forestry and Fishing 2. Mining 3. Construction 4. Manufacturing 5. Transportation, Communications, Electric, Gas and Sanitary Services 6. Wholesale Trade 7. Retail Trade 8. Finance, Insurance and Real Estate 9. Services

Table 3.6: Descriptive statistics for companies' cost of equity

Industry	Mean	Std. Dev.	25th percentile	50th percentile	75th percentile	Skewness	Kurtosis
Panel A: Descriptive statistics for original variables							
1	0.0841	0.0206	0.0690	0.0847	0.0956	0.5343	6.0816
2	0.0875	0.0252	0.0754	0.0835	0.0955	1.031	4.8585
3	0.0870	0.0252	0.0726	0.0817	0.0956	1.8874	10.1614
4	0.0918	0.0285	0.074	0.0884	0.1055	2.5878	25.2898
5	0.0945	0.0298	0.0774	0.0902	0.1038	1.8417	9.1675
6	0.0980	0.0271	0.0788	0.0963	0.1113	0.9438	5.4260
7	0.0865	0.0228	0.0707	0.0830	0.1009	0.4893	3.6051
8	0.0900	0.0258	0.0682	0.0902	0.1038	0.8867	5.0146
9	0.0812	0.0246	0.0650	0.0768	0.0940	1.0061	4.8894
Total	0.0888	0.0277	0.0717	0.0847	0.1026	1.9083	16.747
Panel B: Descriptive statistics for logarithms form of variables							
1	0.0806	0.0189	0.0668	0.0813	0.0913	0.4020	5.8119
2	0.0836	0.0229	0.0727	0.0802	0.0912	0.9349	4.7095
3	0.0832	0.0228	0.0701	0.0785	0.0913	1.7027	9.2150
4	0.0875	0.0254	0.0714	0.0847	0.1003	2.0304	17.9914
5	0.0890	0.0266	0.0746	0.0863	0.0988	1.6591	8.1955
6	0.0932	0.0245	0.0758	0.0920	0.1055	0.8176	5.0598
7	0.0828	0.0209	0.0683	0.0797	0.0961	0.4152	3.5367
8	0.0859	0.0234	0.0659	0.0864	0.0987	0.7785	4.6296
9	0.0778	0.0225	0.0630	0.0740	0.0899	0.9108	4.6153
Total	0.0848	0.0245	0.0692	0.0813	0.0976	1.5376	12.2256

Notes:

1. Cost of capital is measured as internal rate of return (IRR), as equation (3.3) indicates. The data is collected from Worldscope via Thomas one banker for the period 1990 -2011, with 421 firms consisting 3515 firm-year observations.
2. 1-9 indicate the different industry sectors as follows: 1. Agriculture, Forestry and Fishing 2. Mining 3. Construction 4. Manufacturing 5. Transportation, Communications, Electric, Gas, and Sanitary Services 6. Wholesale Trade 7. Retail Trade 8. Finance, Insurance, and Real Estate 9. Services

Table 3.7: Correlation matrix

	Earnings	Cash flow from operations	Cash investments	Cost of capital	Nominal exchange rates	Real exchange rates
Earnings	1					
Cash flow from operations	0.937 ***	1				
Cash investments	0.874 ***	0.933 ***	1			
Cost of capital	0.0522 **	0.0707 ***	0.0687 ***	1		
Nominal exchange rates	-0.0303	-0.0386 *	-0.0258	0.0055	1	
Real exchange rates	-0.0429 *	-0.0607 ***	-0.0275	-0.0027	0.977 ***	1

Notes:

1. All the variables are in logarithms.
2. The data is collected from Worldscope via Thomas one banker for the period 1990 2011, with 421 firms consisting 3515 firm-year observations.

3.4.2 Elasticities of each channel with respect to exchange rates

As discussed in the theoretical framework, exchange rates may influence stock prices through changes in companies' earnings, cash flows from operations, cash investments and cost of equity. The specific size of this relationship depends on the specific responsiveness of each transmission channel to exchange rate fluctuations. In this section we use the data available for each variable to explore this economic flexibility, in order to quantify this pass-through effect.

The models discussed in the empirical modelling section are employed to obtain sensitivities. The data used is the unbalanced panel data for all non-financial UK firms from 1990 to 2011. The results are given in Table 3.8, Table 3.9, Table 3.10 and Table 3.11 for cost of equity, companies' net income cash flows from operations and cash investments respectively. The trade-weighted exchange rates are used in this study in order to reflect the overall trade pattern and competition environment faced by UK firms. Therefore, if the trade-weighted index is increased, it will indicate home currency will generally appreciated against a basket of currencies on average. Since all the UK firms will not only face one type of currency risk due to this globalisation, trade-weighted exchange rate is a better measurement for foreign exchange rate risk for UK companies to reflect the overall currency situation. The sensitivity might be underestimated since the sensitivities obtained are an average of those for both export and import firms, with some effect offset. Ideally, export firms, whose earnings or operations are negatively affected by foreign exchange rates, should be distinguished from import ones, on which the exchange rate has a positive impact. However, since the majority of UK firms both import and export and there is a lack of import inputs and export data, the overall sensitivities are estimated in this chapter.

Table 3.8: Sensitivity of cost of equity to exchange rate

	Nominal Exchange rate	Real Exchange rate
Elasticity	0.0567***	0.0683***
	(0.00775)	(0.00789)
F-statistics	53.59***	75.01***
R^2(within)	0.0160	0.0222
Observations	2226	2226

Notes:

1. The dependent variable is the cost of capital. The nominal exchange rate and real exchange rate are the trade-weighted sterling effective and the trade-weighted sterling board respectively, calculated by the Bank of England.
2. The estimated equation is as follows: $\Delta r_t^i = \alpha_t + \alpha_i + \eta^{r,x} \Delta x_t + \varepsilon_{it}$, using fixed effect for the period 1990 to 2011. In addition, the standard errors are

modified by cluster by firm, since there is both heteroscedasticity and serial correlation in the errors. The standard errors are reported in parenthesis.

3. F-statistics test the null hypothesis that all of the coefficients are jointly zero.
4. *** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Even with the shortcomings of the weighted average results discussed above, there is significant evidence to show that home currency depreciations are associated with lower cost of capital, as shown in Table 3.8. To be specific, 1% depreciation leads to 0.0567% decrease in cost of capital, and this effect can increase to 0.0683% when employing real trade-weighted exchange rates. Table 3.9, Table 3.10 and Table 3.11 present the estimated sensitivities of firms' earnings, cash flow from operations and cash investments respectively. It can be seen that all of these are significantly positively affected by foreign exchange rates. Table 3.9 suggests that an almost entire pass-through of foreign exchange rates to companies' earnings, since the coefficient associated with the nominal exchange rates and real exchange rates is 1 and 1.1 respectively. However, there is less impact of exchange rates on cash flows from operations. Table 3.10 suggests that a 1% depreciation of foreign exchange rates results in an approximately 0.28% decrease in cash flows from operations. That is to say, compared to net income, cash flows are less volatile when foreign exchange rates fluctuate. This is consistent with the findings on risk management. Research suggests that cash flow volatility is costly, and risk managers try to keep cash flows stable in order to increase shareholders'value. (See, for example, Shimko, 1997; Minton & Schrand, 1999; among many others) Cash investments will experience a decrease of 0.85% as a result of currency depreciation by 1%, showing that exchange rates have a greater impact than cash flows from operations. Overall, the estimated results are consistent with the previous research. For example, Bredin and Hyde (2011) found significant evidence to show significant cash flow and discount rate exposures in industry level portfolios in the G7 countries. However, it is worth mentioning that each regression experiences a relatively low R-squared. Efficient market hypothesis (EMH) states that systematic risk has been already priced in stock prices. Therefore, most of the variation left is unexpected noise. This is why a relatively low R-squared has been found in regression.

Table 3.9: Sensitivity of net income to exchange rate

	Nominal Exchange rate	Real Exchange rate
Elasticity	1.017***	1.106***
	(0.255)	(0.265)
F-statistics	15.90***	17.37***
R^2(within)	0.00624	0.00705
Observations	2268	2268

Notes:

1. The dependent variable is companies' earnings. The nominal exchange rate and real exchange rate are the trade-weighted sterling effective and the trade-weighted sterling board respectively, calculated by the Bank of England.
2. The estimated equation is as follows: $\Delta e_t^i = \alpha_t + \alpha_i + \eta^{e,x} \Delta x_t + \varepsilon_{it}$, using a fixed effect for 1990 to 2011. In addition, the standard errors are modified by cluster by firm, since there is both heteroscedasticity and serial correlation in the errors. The standard errors are reported in parenthesis.
3. F-statistics test the null hypothesis that all of the coefficients are jointly zero.
4. *** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 3.10: Sensitivity of cash flows from operations to exchange rate

	Nominal Exchange rate	Real Exchange rates
Elasticity	0.284*	0.279*
	(0.161)	(0.165)
F-statistics	3.089*	2.852*
R^2(within)	0.00148	0.00136
Observations	2268	2268

Notes:

1. The dependent variable is companies' cash flows from operations. The nominal exchange rate and real exchange rate is the trade-weighted sterling effective and the trade-weighted sterling board respectively, calculated by the Bank of England.
2. The estimated equation is as follows: $\Delta cfo_t^i = \alpha_t + \alpha_i + \eta^{cfo,x} \Delta x_t + \varepsilon_{it}$, using a fixed effect for 1990 to 2011. In addition, the standard errors are modified by cluster by firm, since there is both heteroscedasticity and serial correlation in the errors. The standard errors are reported in parenthesis.
3. F-statistics test the null hypothesis that all of the coefficients are jointly zero.
4. *** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 3.11: Sensitivity of cash investments to exchange rate

	Nominal Exchange rate	Real Exchange rates
Elasticity	0.851***	0.881***
	(0.217)	(0.223)
F-statistics	15.42***	15.66***
R^2(within)	0.00741	0.00758
Observations	2251	2251

Notes:

1. The dependent variable is companies' cash investments. The nominal exchange rate and real exchange rate are the trade-weighted sterling effective

and the trade-weighted sterling board respectively, calculated by the Bank of England.

2. The estimated equation is as follows: $\Delta ci_t^i = \alpha_t + \alpha_i + \eta^{ci,x} \Delta x_t + \varepsilon_{it}$, using a fixed effect for 1990 to 2011. In addition, the standard errors are modified by cluster by firm, since there is both heteroscedasticity and serial correlation in the errors. The standard errors are reported in parenthesis.
3. F-statistics test the null hypothesis that all of the coefficients are jointly zero.
4. *** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Given this evidence, in the calibration exercises it is assumed that values for $\eta^{e,x}$ fall between 1.1 and 0,for $\eta^{cfo,x}$ between 0.3 and 0, for $\eta^{ci,x}$ between 0.9 and 0, and for $\eta^{r,x}$ between 0.07 and 0, in response to a 1% home currency depreciation. It means that the companies' earnings, cash flows from operations, cash investments and cost of equity can either be unchanged, or lower by 1.1%, 0.3%, 0.9% and 0.07% respectively, when exchange rates depreciate by 1%. Furthermore, it is assumed that these elasticities are identical across industries. This assumption might not be accurate for each industry separately. However, this study focused on the transmission channels through which exchange rates affect stock prices for all the UK firms. Therefore, this assumption might be reasonable for analysing the overall impact of foreign exchange rate on equity prices, which is consistent with the methodology in previous literature. (Goldberg & Campa, 2010)

Given that consequences of different shocks depend on flexibility of economics, full range of earnings, cash flows from operations, cash investments and cost of equity flexibility option will be employed in order to demonstrate that these "flexibility" can result in various effects of stock prices with respect to exchange rates.

3.5 Calibration of stock price elasticities with respect to exchange rates

In this section, stock price elasticities with respect to exchange rates will be calibrated so that important implications can be given. This calibration exercise can not only generate quantitatively sound sensitivity of stock price to exogenous exchange rates, but also the sources of this sensitivity can be decomposed in order to find the key drivers of the effect of globalization on this sensitivity. In specific, this section addresses the predication of the model by calibrating the transmission rates from exchange rate movements into stock prices. The model-based predicted exchange rate pass-through into stock price is generated using calibrated sensitivities, as well as the rich data on companies' earnings, cash flows from operations, cash investments, and cost of equity in Section 3.4. In addition, a variant on these predictions is provided, showing the sensitivity of all predictions to the models' assumed parameters.

Table 3.12 reports on Discounted Dividend model, the Free Cash Flow model and the Residual Earnings model respectively. The first column reports results based on the discounted dividend model. It implies that pass- through of exchange rates into stock prices occurs because of the cost of equity used in share valuation modelling, which is sensitive to exchange rates. Differences across industries in pass-through into stock price based on the discounted dividend model are clearly driven by the value of the cost of equity, since many other calibration parameters are identical across industries. Our evidence of cost of equity value shows that the industry with the highest cost of equity is the wholesale trade industry, thus resulting in the highest pass-through into share price for this industry as well. Similarly, the services industry has the lowest pass-through and is also driven by the low value of cost of equity across industries. In addition, there is no great difference of cost of equity across industries, leading to stock price elasticities that are around 0.98 across all industries. Overall, the Discounted Dividend model suggests that exchange rate pass-through should be almost complete, and that cost of capital is the only transmission channel for this effect.

Table 3.12: Calibrated price elasticities with regard to exchange rate

Model	DDM	FCF	RE
	(1)	(2)	(3)
Assumptions: $\eta^{r,x}$	0.07	0.07	0.07
$\eta^{e,x}$	1.1		1.1
$\eta^{cfo,x}$		0.3	
$\eta^{ci,x}$		0.9	
Calibrated overall price elasticities : $\eta^{p,x}$			
Agriculture, Forestry and Fishing	0.9831	-0.1812	1.3643
Mining	0.9819	-0.0276	1.1910
Construction	0.9801	0.0633	1.2708
Manufacturing	0.9863	-0.0339	1.3139
Transportation, Communications, Electric, Gas and Sanitary Services	0.9877	-0.1319	1.2202
Wholesale Trade	0.9918	-0.0174	1.3164
Retail Trade	0.9815	-0.1124	1.1858
Finance, Insurance and Real Estate	0.9877	0.1294	1.4537

Services	0.9744	0.0418	1.3374
Total	0.9831	-0.0301	1.2664

Notes:

1. Column (1), (2) and (3) present the calibrated elasticities of stock prices with respect to exchange rates, based on different share valuation models. DDM stands for Discounted Divided Model, FCF is the Free Cash Flow Model and RE refers to Residual Earnings Model.
2. The calibration is calculated by the equations (3.4), (3.7), (3.11) respectively, assumes stable growth rate g=0.034, $\eta^{e,x}$, $\eta^{cfo,x}$ $\eta^{ci,x}$ and $\eta^{r,x}$ are 1.1, 0.3, 0.9 and 0.07 respectively, as estimated in Section 3.4.2.
3. The earnings, cash flows from operations, cash investments and cost of equity are the sample's medians.

The second column shows calibration price elasticities with respect to exchange rates based on the free cash flow model. The free cash flow model indicates that cash flows, such as cash flows from operations and cash investments, and cost of equity, all result in the pass- through of exchange rates into stock prices. When cash flows from operations rise, exchange rate pass-through effect decreases. However, this impact can be mitigated by adding two other transmission channels: cash investments and cost of equity, as suggested by the free cash flow model. Therefore, it can be observed that although the cash flow from operations for the mining industry is the highest, the pass-through is not the lowest of the industries due to the relatively high cash investments. Instead, the wholesale industry experienced a 0.017% decrease when exchange rates grew by 1%, which is the lowest of all the industries. In general, the free cash flow model suggests that there is a very low pass-through effect (-0.03), since the negative effect via cash flows from operations can be greatly mitigated by the impact of the cash investments channel and the cost of capital channel.

The final column reports the calibration sensitivities across industries, based on the residual earnings model. In the residual earnings model, it is suggested that not only cost of equity but also earnings are transmission channels through which changes in exchange rates pass- through into stock prices. Similarly to both the Discounted Dividend model and the Free Cash Flow model, cost of equity can be viewed as a positive channel through which pass-through increases as a result of rising cost of equity. However, the industry-based differences in calibrated stock price elasticities are also closely tied to differences in companies' earnings, suggested by the Residual Earnings model. It can be seen that there are relatively large differences across industries for stock price pass-through effects as a result of from various companies' earnings, although there is not such a great difference for cost of equity across industries. When companies' earnings rise, there is less pass-through effect into equity price. For example, the earnings from the mining industry are relatively high, thus leading to a lower pass-through impact of exchange rates on stock prices.

Generally speaking, the Residual Earnings model suggests that the changes in exchange rates should be more than fully pass-through into stock prices via both the earnings channel and the cost of capital channel, indicated by the fact that elasticity equals 1.266 on average.

A number of interesting observations emerge from this table when comparing column (1), (2) and (3). First, there are substantial industry differences in calibrated price sensitivity with respect to exchange rates in some industries. For example, it is suggested that the retail trade industry experiences a relatively low pass-through in all three models, while these three share valuation models suggest a relatively high pass-through effect for the wholesale trade industry. However, there are essential differences in the implications of the models. To be specific, the Discounted Dividend model suggests that exchange rates should affect stock prices via only changes in cost of capital, but both the Free Cash Flow model and the Residual Earnings model advocate addition of revenue-side transmission channels, either via cash flows or earnings. In other words, there is only one positive transmission channel for exchange rate pass-through effect suggested by the Discounted Dividend model. In terms of the Free Cash Flow model and the Residual Earnings model, both the positive cost channel and the negative revenue channel are supported, thus indicating different overall stock price sensitivities. For example, while it is suggested by the Discounted Dividend model that the service industry exhibits a relatively lower pass-through effect, both the Free Cash Flow model and the Residual Earnings model suggest that it should experience one of the highest elasticities of all industries. Similarly, for the transportation, communications, electric, gas, and sanitary services industries, overall price sensitivity is suggested to be high by the Discounted Dividend model, but low by the other two models. The reason might be the opposite impact through the revenue-side channel, which can offset the effect through the cost-side channel to some extent. Although both suggest two kinds of transmission channels, it is would be an arbitrary conclusion that the Free Cash Flow model and the Residual Earnings model always have consistent implications. For example, the Free Cash Flow model suggests that the agricultural, forestry and fishing industries should experience the lowest pass-through effect, while this is suggested to be the highest overall price elasticity of all industries except finance, insurance, and real estate industry. This might be due to the accrual accounting method, which results in huge differences between companies' earnings and their cash flows. In addition, the very different elasticity magnitudes suggested by these three share valuation models are also worth noting. Of all three models, price sensitivities based on the Residual Earnings model are the highest (1.266), indicating that foreign exchange rate pass-through effect is more than complete. The Discounted Dividend model suggests there should be almost full pass-through for exchange rates to stock prices, indicated by the fact that elasticity equals to 0.98. The smallest sensitivity is suggested by the Free Cash Flow model. As opposed to the positive elasticities suggested by either the Discounted Dividend model or the Residual Earnings model, the Free Cash Flow model suggests positive sensitivities for only the construction, service, finance, insurance, and real estate industries, with all the remaining industries exhibiting negative stock price elasticities. On average, overall stock price sensitivity to exchange rates is only -0.03, suggesting little impact of exchanges rates on stock prices.

Based on evidence of earnings, cost of equity, cash flows from operations and cash investments, as well as the component elasticities reported in Table 3.12, the sources of this price sensitivity can be decomposed. Based on the Discounted Dividend model, it is suggested that cost of equity should be the only channel through which changes in exchange rates pass-through into stock prices. Therefore, 100% of stock price sensitivity results from cost of equity. However, research suggests that this should be decomposed into cash flows or earnings components, and interest rate or discount rate components. (Bredin & Hyde, 2011) According to column (1) and (2) in Table 3.13, more than 85% of stock price sensitivity comes from companies' cash flows, including cash flows from operations and cash investments, with less than 15% of share price elasticity associated with cost of equity used in share valuation modelling, as suggested by Free Cash Flow model. These results are consistent with research by Bredin and Hyde (2011). Bredin and Hyde (2011) decomposed foreign exchange rate exposure into cash flow and discount rate components. Furthermore, it is found that although industries have significant cash flow and discount rate exposure, cash flow is a dominant channel compared to the discount rate channel. Comparing column (3) and (4) in Table 3.13, it is found that the earnings can explain more than 90% of stock price sensitivity, and around 10% or less of the share price elasticity comes from cost of equity suggested by the residual earnings model. That is to say, the residual earnings model confirms the dominant role of revenue-side transmission channels compared to cost-side channels.

Table 3.13: Decomposition sources for stock price sensitivity

	Free cash flow model		Residual earnings model	
Industry	(1) percentage due to cash flows	(2) percentage due to cost of equity	(3) percentage due to earnings	(4) percentage due to cost of equity
Agriculture, Forestry and Fishing	89.79%	10.21%	92.68%	7.32%
Mining	85.89%	14.11%	91.73%	8.27%
Construction	81.66%	18.34%	92.06%	7.94%
Manufacturing	86.68%	13.32%	92.62%	7.38%
Transportation, Communications, Electric, Gas and Sanitary Services	89.31%	10.69%	92.22%	7.78%
Wholesale Trade	86.91%	13.09%	92.94%	7.06%
Retail Trade	88.22%	11.78%	91.67%	8.33%
Finance, Insurance, And Real Estate	78.76%	21.24%	93.31%	6.69%
Services	81.82%	18.18%	92.09%	7.91%
Total	86.13%	13.87%	92.21%	7.79%

Notes:

1. The percentage is calculated by the following equation: $A\% = \frac{|A|}{|A|+|B|} * 100\%$, where, A% is the percentage due to A, || stands for the absolute value.
2. All the data used here is the same as in Section 3.4.

Table 3.14: Exchange rate pass-through elasticities, under alternative assumptions

Panel A: Discounted Dividend Model								
Assumptions:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\eta^{r,x}$	0.00	0.00	0.07	0.07				
$\eta^{e,x}$	0.00	1.00	0.00	1.00				
Results:								
$\eta^{p,x}$	0.00	1.00	-0.12	0.88				
Panel B: Free Cash Flow Model								
Assumptions:								
$\eta^{r,x}$	0.00	0.00	0.00	0.07	0.07	0.07	0.07	0.07
$\eta^{cfo,x}$	0.00	0.30	0.00	0.00	0.30	0.00	0.30	0.30
$\eta^{ci,x}$	0.00	0.00	0.90	0.00	0.00	0.90	0.00	0.90
Results:								
$\eta^{p,x}$	0.00	0.41	-0.32	-0.12	0.29	-0.44	0.09	-0.03
Panel C: Residual Earnings Model								
Assumptions:								
$\eta^{r,x}$	0.00	0.00	0.07	0.07				
$\eta^{e,x}$	0.00	1.00	0.00	1.00				
Results:								
$\eta^{p,x}$	0.00	1.26	-0.12	1.14				

Notes:

1. $\eta^{e,x}$, $\eta^{cfo,x}$ $\eta^{ci,x}$ and $\eta^{r,x}$ are the sensitivities for each component, namely elasticity of earnings, cash flows from operations, cash investments and cost of equity respectively. $\eta^{p,x}$ is the overall stock price sensitivity with regard to exchange rates, and is calculated by the model developed in the theoretical modelling section.

The top panel in Table 3.14 provides alternative parameter values for calibrations, and the bottom panel shows the results according to different valuation assumptions. Based on the discounted dividend model, it can be seen from panel A that there will be no exchange rate pass-through effect for stock prices if both cost of capital and earnings are not sensitive to foreign exchange rates. If only the companies' earnings are sensitive to the exchange rates, the overall stock price sensitivity should be the same as the earnings' elasticities. However, this sensitivity can be decreased by cost of capital flexibility. In other words, when elasticity of cost of equity rises, overall stock prices will respond less to exchange rates, as seen when comparing columns (2) and (4) in Table 3.14. Similarly to the Discounted Dividend model, the Residual Earnings model also indicates the positive effect of earnings' sensitivity and the negative impact of cost of equity elasticity on the pass-through effect of exchange rates. The only difference is that earnings' sensitivity to exchange rates makes a greater impact on overall stock price elasticity based on the residual earnings model than in the conclusions suggested by the Discounted Dividend model. As shown in Panel C in Table 3.14, the Residual Earnings model suggests a higher overall price elasticity (1.26) of stock prices with respect to exchange rates than the discounted dividend model (1.00), although the earnings' sensitivities are the same in both. Panel B in Table 3.14 presents results based on the Free Cash Flow model, under alternative assumptions. Firstly, it confirms the positive effect of elasticity of cash flows from operations on exchange rates. For example, if only cash flows from operations are sensitive to foreign exchange rates, overall stock price sensitivity can be 0.41 as a result of $\eta^{cfo,x} = 0.3$. Furthermore, sensitivities of cost of equity and cash investments are both suggested to be negatively related to the overall sensitivity of the stock price, as indicated by the negative values in column (3) and (4). More importantly, it is worth noting that both the Free Cash Flow model and the Residual Earnings model suggest a higher impact of the sensitivities of the revenue-side (cash flow from operations or earnings), as shown in column (2). However, the free cash flow model also adds one negative channel - cash investments. In other words, the effect of exchange rates on stock price elasticity can be dampened a great deal through the rise of cash investments' sensitivity with regard to exchange rates. Therefore, it can be observed that the Residual Earnings model suggests the highest overall stock price sensitivity, followed by the Discounted Divided model, and the Free Cash Flow model indicates the lowest sensitivity.

So far, this section has shown that that pass-through elasticity of exchange rates into stock prices depends greatly on the companies' earnings or cash flows, but also on the firm's cost of equity. Furthermore, the sensitivities of each component to exchange rate movements also play an important role in the scale of calibrated share price pass-through elasticities.

3.6 Further analysis

In order to further explore the exchange rate pass-through effect, this section compares our firmly established results with the noisy estimated overall stock price sensitivities. Columns (1), (2) and (3) in Table 3.15 show the calibrated overall stock price elasticities to exchange rates, while the estimated ones are presented in column (4). On average, noisy estimated stock price sensitivity is 1.141, and only five of the nine industries are found to be significantly affected by foreign exchange rates. It is worth mentioning that the Residual Earnings model is the one that suggests that the most similar results to the noisy estimated ones, of all three models. Specifically, indicate that exchange rate pass-through into stock prices is more than complete and positive. However, there are greater differences across industries for noisy estimated sensitivities than the model suggests. It is argued that noisy estimated sensitivities are difficult to interpret, therefore justifying the calibration benchmarks in this chapter. This gap can be explained in the following ways. Firstly, some companies employ hedging techniques to manage exposures. Secondly, some of the assumptions might not be appropriate.

Table 3.15 Comparison with estimated stock price elasticities

	Model calibrated			Estimated
	DDM	FCF	RE	
	(1)	(2)	(3)	(4)
1	0.9831	-0.1812	1.3643	1.7628
2	0.9819	-0.0276	1.1910	1.0696
3	0.9801	0.0633	1.2708	1.6662**
4	0.9863	-0.0339	1.3139	0.6036***
5	0.9877	-0.1319	1.2202	1.0860**
6	0.9918	-0.0174	1.3164	0.7095
7	0.9815	-0.1124	1.1858	1.5543**
8	0.9877	0.1294	1.4537	0.0564
9	0.9744	0.0418	1.3374	2.1203***
Total	0.9831	-0.0301	1.2664	1.1410***

Notes:

1. 1-9 indicate the different industry sectors as follows: 1. Agriculture, Forestry and Fishing 2. Mining 3. Construction 4. Manufacturing 5. Transportation, Communications, Electric, Gas and Sanitary Services 6. Wholesale Trade 7. Retail Trade 8. Finance, Insurance and Real Estate 9. Services
2. Model calibrated values are calculated from the theoretical models developed in Section 3.2. Estimated values are the noisy stock price elasticities estimated

from the following equation: $\Delta p_t^i = \alpha_t + \alpha_i + \eta^{p,x} \Delta x_t + \varepsilon_{it}$, where p is the stock price, and x is the foreign exchange rates. Both of them are in their log first differences.

3. *** Significant at 1% level, ** significant at 5% level, * significant at 10% level

3.7 Concluding remarks

This chapter contributes to current research by merging accounting valuation models with exchange rate risk literature. In specific, this chapter has explored the scale of the main channels through which changes in exchange rates pass through into share values. We begin with three widely employed share valuation models including the Discounted Dividend model, the Free Cash Flow model and the Residual Earnings model, and then overall stock price elasticity with regard to exchange rates is decomposed into various components. Based on the Discounted Dividend model, only cost of equity is recognized as the potential channel through which changes in exchange rates pass-through into stock prices. However, both the Free Cash Flow model and the Residual Earnings model suggest adding the revenue-side transmission channel to the cost-side one. The Residual Earnings model suggests that overall elasticity of stock price to exchange rate can be decomposed into sensitivity of earnings and cost of equity with respect to exchange rates. In terms of the Free Cash

Flow model, it is suggested that there are three components for overall elasticity of stock price, and these are sensitivity of cash flows from operations, sensitivity of cash investment, and sensitivity of cost of capital with respect to exchange rate.

In order to make the theoretical framework operational, the sensitivity of each component with regard to exchange rates is obtained from the empirical estimation, and can be used to calculate the calibration of overall stock price elasticity with regard to exchange rates. Finally, it is seen that the Residual Earnings model suggests that the exchange rate pass-through effect should be more than complete, followed by the implications of the Discounted Dividend model (0.98), and the free cash flow model suggests the lowest pass-through effect (-0.03). This huge difference between the three models can be explained as follows. The Residual Earnings model and the Free Cash Flow model emphasize their effect via the revenue-side channel, and therefore the overall stock price sensitivities based on these two models are greatly affected by this component as well. However, the Free Cash Flow model also indicates negative impact through the cash investments channel, which greatly influences total elasticities.

In addition, the main drivers of the exchange rates effect were also examined. Earnings or cash flows from operations are found to be the main channels through which changes in exchange rates pass-through into stock prices. More specifically, more than 85% of overall price sensitivity to exchange rates arises from sensitivity of earnings or from cash flows from operations. This finding is consistent with research, such as Campbell & Vuolteenaho (2004), Bartram's (2008), et al. However, this effect can be reduced to some extent through the cost of equity channel. In general, this chapter makes an initial attempt at exploring the transmission channels through which changes in exchange rates pass-through into stock prices from a theoretical perspective, and also employ calibrations to provide useful results. Therefore, it is of the utmost importance to understand the nature of the exchange rate pass-through effect, thus enhancing our understanding of the impact on firms' value and making hedging more efficient in practice.

Appendix 3.A: Demonstration of equality of two measurements

$$d\ln x_t = \frac{1}{x_t} * dx_t \, , \quad d\ln p_t = \frac{1}{p_t} * dp_t$$

Thus, $$\frac{d\ln p_t}{d\ln x_t} = \frac{\frac{1}{p_t} * dp_t}{\frac{1}{x_t} * dx_t} = \frac{dp_t}{dx_t} * \frac{x_t}{p_t}$$

Appendix 3. B1: Derivation of overall elasticities of stock prices with respect to exchange rates, based on Discounted Dividend model

Let us begin with the discounted divide model with a stable growth rate g, which is the Gordon Growth Model in accounting literature.

$$V_t^e = \frac{D_{t+1}}{r_t - g} \qquad \text{(B1.1)}$$

Where, V_t^E is the value of equity at time t, Dt+1 represents the dividends paid at time t+1, r is the cost of capital and g refers to the dividend stable growth rate. Research suggests that this model should work best for firms with a fixed pay-out ratio; therefore, the dividends can be seen as earnings multiplied by pay-out ratio. The equation (B1.1) can be written as follows:

$$V_t^e = \frac{Pay\text{-}out\ ratio * e_t}{r_t - g} \qquad \text{(B1.2)}$$

Here, e is the companies' earnings, and all the others terms are defined the same as above. Furthermore, earning and cost of capital are affected by the exchange rates. If we use e_t (e_t: x_t) and r_t (r_t: x_t) to stand for earnings and equity cost of capital, which are both affected by exchange rates respectively, the equation can be written as (B1.3).

$$V_t^e = \frac{Payout - ratio * e_e(e_t : X_t)}{r_t(r_t : X_t) - g} \qquad \text{(B1.3)}$$

Here, X_t is the foreign exchange rates. In addition, if we divide the value of equity by the number of shares outstanding at that time, the equity value then can be obtained by equation (B1.4)

$$P_t = \frac{V_t^e}{share-outs\tan ding} = \frac{1}{s} * \frac{Payout-ratio * e_t(e_t : X_t)}{r_t(r_t : X_t) - g} \quad \text{(B1.4)}$$

s is the number of shares outstanding for a firm at time t. We can then take the first differentiation of this equity valuation equation (B1.4) with respect to exchange rates, in order to obtain the overall elasticities of stock prices to exchange rates, as shown in equation (B1.5)

$$\eta^{p,x} = \frac{\partial P_t}{\partial X_t} * \frac{X_t}{P_t} = \frac{\partial \frac{1}{s} * \frac{payout-ratio * e_t(e_t : X_t)}{r_t(r_t : X_t) - g}}{\partial X_t} * \frac{X_t}{\frac{payout-ratio * e_e}{s*(r_t - g)}}$$

$$= \frac{(r_t - g) * Payout-ratio * \frac{\partial e_t}{\partial X_t} - Payout-ratio * e_t * \frac{\partial (r_t - g)}{\partial X_t}}{s*(r_t - g)^2} * \frac{X_t (r_t - g) * s}{Payout-ratio * e_t}$$

$$= \frac{\partial e_t}{\partial X_t} * \frac{X_t}{e_t} - \frac{\partial (r_t - g)}{\partial X_t} * \frac{X_t}{r_t - g}$$

$$= \eta^{e,x} - \eta^{r,x} * \frac{r_t(r_t : X_t)}{r_t(r_t : X_t) - g}$$

(B1.5)

Where, $\eta^{e,x} = \frac{\partial e_t}{\partial X_t} * \frac{X_t}{e_t}$, $\eta^{r,x} = \frac{\partial (r_t - g)}{\partial X_t} * \frac{X_t}{r_t} = \frac{\partial r_t}{\partial X_t} * \frac{X_t}{r_t}$ (B1.6)

Here, $\eta^{p,x}$ is overall sensitivity of stock price with regard to foreign exchange rates, $\eta^{e,x}$ is the exchange rate pass-through into the company's earnings and $\eta^{r,x}$ is the elasticity of cost of equity with regard to exchange rates. Moreover, r_t (r_t: X_t) is the cost of equity, which is affected by foreign exchange rates, and g is the stable growth rate.

Appendix 3.B2: Derivation of overall elasticities of stock prices with respect to exchange rates, based on Free Cash Flow model

Let us begin with the relationship between value of firm, equity and debt as shown in equation (B2.1).

$$V_t^f = V_t^e + V_t^D \tag{B2.1}$$

Here, V_t^e, V_t^f, and V_t^D are the value of equity, value of firm and book value of debt at time t respectively. Equation (B2.1) suggests that the sum of value of equity and book value of debt add up to the value of firm. On the other hand, the free cash flow model values the value of a firm as present values of all expected free cash flows. If the free cash flows are assumed to grow at a constant rate at the first horizon, the equation takes the following form:

$$V_t^f = \frac{FCF_t}{r_t - g} \tag{B2.2}$$

Here, V_t^f is the value of firm at time t; FCF_t refers to the free cash flow for the company at time t; r is the cost of capital for the firm; and g is the stable growth rate for free cash flows. Since free cash flow is defined as "part of the cash from operations that is 'free' after the firm reinvests in new assets", the equation can be written as: (Penman, 2010)

$$V_t^f = \frac{CFO_t - CI_t}{r_t - g} \tag{B2.3}$$

Here, CFO stands for cash flows from operations, which are cash inflows for a company, while CI refers to cash investments, which are cash outflows for a firm. According to accounting literature, it is very common to deduct only capital expenditure as cash investments, which is a common approximation in calculation. In addition, stock price can be calculated by dividing the value of equity by the number of shares outstanding at that time. The stock price can be calculated by equation (B2.4)

$$P_t = \frac{V_t^e}{s} = \frac{V_t^f - V_t^D}{s} = \frac{1}{s} * [\frac{CFO_t(CFO_t : X_t) - CI_t(CI_t : X_t)}{r_t(r_t : X_t) - g} - V_t^D] \tag{B2.4}$$

Here, s is the number of shares outstanding for a company at time t. CFOt(CFOt: xt), CIt(CIt: xt), and rt(rt: xt) refer to the cash flow from operations, cash investments and cost of capital for firms, all of which will be affected by exchange rates. Since the book value of debt will not be affected by exchange rate, the differentiation of stock price with respect to exchange rate should be the same as elasticity of value of firm per share to exchange rates as equation (B2.5) shows

$$\frac{\partial P_t}{\partial X_t} = \frac{\partial \frac{V_t^e}{s}}{\partial X_t} = \frac{1}{s} * \frac{\partial (V_t^f - V_t^D)}{\partial X_t} = \frac{1}{s} * \frac{\partial V_t^f}{\partial X_t} \tag{B2.5}$$

Therefore, taking equation (B2.5) and (B2.4) into the elasticity definition equation, the overall elasticity of the stock prices with respect to exchange rates can be obtained by the following equation:

$$\eta^{p,x} = \frac{\partial P_t}{\partial X_t} * \frac{X_t}{P_t} = \frac{1}{s} * \frac{\partial V_t^f}{\partial X_t} * \frac{X_t}{P_t} = \frac{1}{s} * \frac{\partial \frac{CFO_t(CFO_t : X_t) - CI_t(CI_t : X_t)}{r_r(r_r : X_t) - g}}{\partial X_t} * \frac{X_t}{\frac{CFO_t - CI_t}{(r_t - g) * s}}$$

$$= \frac{(r_t - g) * (\frac{\partial CFO_t}{\partial X_t} - \frac{\partial CI_t}{\partial X_t}) - (CFO_t - CI_t) * \frac{\partial (r_t - g)}{\partial X_t}}{s * (r_t - g)^2} * \frac{X_t (r_t - g) * s}{CFO_t - CI_t}$$

$$= (\frac{\partial CFO_t}{\partial X_t} - \frac{\partial CI_t}{\partial X_t}) * \frac{X_t}{CFO_t - CI_t} - \frac{\partial (r_t - g)}{\partial X_t} * \frac{X_t}{r_t - g} \tag{B2.6}$$

In conclusion, the Free Cash Flow model suggests that the overall elasticity of stock prices with respect to exchange rates should be obtained by equation (B2.7), if we define $\eta^{CFO,x}$, $\eta^{CI,x}$ and $\eta^{r,x}$ are the elasticities of cash flow from operations, cash investments and equity cost of capital with respect to foreign exchange rates respectively.

$$\eta^{p,x} = \eta^{cfo.x} * \frac{CFO(CFO_t : X_t)}{CFO(CFO_t : X_t) - CI(CI_t : X_t)} - \eta^{ci,,x} * \frac{CI(CI_t : X_t)}{CFO(CFO_t : X_t) - CI(CI_t : X_t)}$$
$$- \eta^{r,x} * \frac{r(r_t : X_t)}{r(r_t : X_t) - g}$$

(B2.7)

Where, $\eta^{p,x} = \frac{\partial (r-g)}{\partial X_t} * \frac{X_t}{r_t} = \frac{\partial r_t}{\partial X_t} * \frac{X_t}{r_t}$, $\eta^{cfo,x} = \frac{\partial CFO_t}{\partial X_t} * \frac{X_t}{CFO_t}$,

$$\eta^{ci,x} = \frac{\partial CI_t}{\partial X_t} * \frac{X_t}{CI_t}$$

(B2.8)

Here, $\eta^{cfo,x}$, $\eta^{ci,x}$ and $\eta^{r,x}$ are the elasticities of cash flow from operations, cash investments and equity cost of capital with regard to foreign exchange rates respectively, and g refers to stable growth rate as above. CFO (CFOt:Xt), CI(CIt:Xt) and r(rt:Xt) are cash flows from operation, cash investments and cost of capital for a company respectively, all of which are affected by foreign exchange rates.

Appendix 3.B3: Derivation of overall elasticities of stock prices with respect to exchange rates, based on Residual Earnings model

Let begin with the clean surplus relation in accounting as equation (B3.1) shows.

$$B_t = B_{t-1} + e_t - D_t \tag{B3.1}$$

Here, B_t and B_{t-1} are the book value of equity at time t and t-1 respectively; e_t is the comprehensive earnings for period from t-1 to t; and D_t stands for the dividends paid at time t. Therefore, if the residual earnings are assumed to be growing at a stable growth rate g in the first period, the residual earnings model will take the following form:

$$V_t^e = B_t + \frac{RI_{t+1}}{r_t - g} \tag{B3.2}$$

Here, V_t^e is the value of equity at time t, B_t is the book value of equity at time t, RI_{t+1} stands for the residual earnings during t to t+1, r is the equity cost of capital, and g is the residual stable growth rate. This model suggests that the equity value is the sum of book value of equity at the first time and all discounted value added by residual earnings in the future. Residual earnings are the “extra” earnings by the company, which are the remainder of the comprehensive earnings minus the previous book value times required return on it, as equation (B3.3) shows

$$RI_t = e_t - r_t * B_{t-1} \tag{B3.3}$$

Here, e_t is the comprehensive earnings of companies from t-1 to t, and all the other variables are defined the same as above. Thus, taking equation (B3.3) into equation (B3.2), the value of equity can be written as follows:

$$V_t^e = B_t + \frac{e_t - r_t * B_t}{r_t - g} = \frac{e_t - B_t * g}{r_t - g} \tag{B3.4}$$

The stock price can be obtained by dividing the value of equity by the number of shares outstanding (s) at that time, as shown in equation (B3.5).

$$p_t = \frac{V_t^e}{share - outs\tan ding} = \frac{e_t(e_t : X_t) - B_t * g}{(r_t(r_t : X_t) - g) * s} \tag{B3.5}$$

In this equation, comprehensive earnings and cost of equity are recognized as potential channels through which changes in exchange rates pass-through into stock prices, which are defined as $e_t(e_t{:}X_t)$ and $r_t(r_t{:}X_t)$. Therefore, according to the definition, exchange rate pass-through can be calculated from equation (B3.6).

$$\begin{aligned} \frac{\partial P_t}{\partial X_t} * \frac{X_t}{P_t} &= \frac{\partial \dfrac{e_t(e_t : X_t) - B_t * g}{(r_t(r : X_{tt}) - g) * s}}{\partial X_t} * \frac{X_t}{\dfrac{e_t - B_t * g}{(r_t - g) * S}} \\ &= \frac{(r - g) * \dfrac{\partial e_t}{\partial X_t} - (e_t - B_t * g) * \dfrac{\partial (r_t - g)}{\partial X_t}}{s * (r_t - g)^2} * \frac{X_t * (r_t - g) * s}{e_t - B_t * g} \end{aligned} \tag{B3.6}$$

In conclusion, the residual earnings model suggests that the overall elasticity of stock prices with regard to exchange rates should calculated as equation (B3.7).

$$\eta^{p,x} = \frac{\partial P_t}{\partial X_t} * \frac{X_t}{P_t} = \eta^{e,x} * \frac{e_t(e_t : X_t)}{e_t(e_t : X_t) - B_t * g} - \eta^{r,x} * \frac{r_t(r_t : X_t)}{r_t(r_t : X_t) - g} \tag{B3.7}$$

Where, $\eta^{e,x} = \frac{\partial e_t}{\partial X_t} * \frac{X_t}{e_e}$, $\eta^{r,x} = \frac{\partial r_t}{\partial X_t} * \frac{X_t}{r_t}$ (B3.8)

Here $\eta^{e,x}$ is earnings sensitivity with gard to foreign exchange rates for a firm, and $\eta^{r,x}$ is elasticity of equity cost of capital with regard to exchange rates. Moreover, e_t (e_t:X_t) and r_t(r_t:X_t) refer to the comprehensive earnings for a firm during period t and the cost of equity respectively, both of which will be affected by foreign exchange rates. In addition, g is the stable growth rate, and Bt is the book value of equity at time t.

Appendix 3.C: Industry decomposition

Industry	No. of Firms	No. of Obs.	%Sample
Agriculture, Forestry, And Fishing	5	46	1.31%
Mining	11	86	2.45%
Construction	16	135	3.84%
Manufacturing	175	1544	43.93%
Transportation, Communications, Electric, Gasand Sanitary Services	32	279	7.94%
Wholesale Trade	19	180	5.12%
Retail Trade	39	315	8.96%
Finance, Insurance and Real Estate	7	57	1.62%
Services	117	873	24.84%
Total	421	3515	100.00%

Appendix 3.D: Diagnostics of regressions of elasticities of each component

	Diagnostics	
(1) earnings regression	Heteroskedasticity	No autocorrelation
(2) cash flow from operations regression	Heteroskedasticity	No autocorrelation
(3) cash investments regression	Heteroskedasticity	No autocorrelation
(4) cost of equity regression	Heteroskedasticity	Autocorrelation

CHAPTER 4

EXCHANGE RATE PASS-THROUGH EFFECT: FIRM-LEVEL EMPIRICAL EVIDENCE

4.1 Introduction

Foreign exchange rate exposure has drawn research interests in order to hedge portfolios for investors or make risk management decisions for corporate managers. Besides the majority of the literature focuses on whether the exchange rate is priced in the stock market, last research chapter traces the transmission channels through which the changes in exchange rates pass-through into stock prices, which firstly provides evidence as to how and why stock prices are affected by foreign exchange rates from a theoretical point of view. This chapter will extend the work to form an empirical model which will examine the exchange rate pass-through effect for UK firms from an empirical aspect. Empirical studies have found mixed results for total foreign exchange rate exposure based on firm-level data. For example, Friberg and Ganslandt (2007) employed the Monte Carlo approach in the bottled water market, and suggested that different firms with various brands face very different exchange rate exposure, even in a relatively simple market. It is therefore vital to ask why firms face different foreign exchange exposures. To this end, this chapter will firstly provide empirical evidence for the theoretical framework in Chapter 3, as well as studying the determinants of foreign exchange rate pass-through effects.

Although financial theory suggests significant foreign exchange exposure for firms, empirical studies saw a relatively low level of significance for firm-level data. In other words, not all firms face the same level of exchange rate risk. While some firms are significantly exposed to foreign exchange rate risk, some are not. For example, Bartram (2007) employed daily US firm data and suggested only 13.2% of the sample are significantly exposed to foreign exchange rate risk. A similar result is found by Aggarwal and Harper (2010) using monthly, quarterly, and annually data. Although within all the significant firm-level foreign exchange rate exposures, there are huge dispersions, some positive and some negative. For users of exchange rate exposure, whether investors or risk managers, Bodnar and Wong (2003) claimed that they should be understandably put off by the lack of reliable economic interpretation of these differences. (Bodnar and Wong, 2003) Therefore, this chapter attempts to explain the currency exposure differences. Specifically, based on the implications from Chapter 3, this chapter will investigate whether some transmission channels only work for particular companies, which leads to various exchange rate exposures for different companies.

Previous research suggests three main characteristics in firms; size, leverage and foreign sales ratio should be essential explanations for different exchange rate exposures. Firstly, size is proved to be related to currency exposure although the relationship can be ambiguous. On the one hand, large firms are more internationally-orientated and thus are more exposed to foreign exchange rates risks. (See, for example, He and Ng, 1998; Bartram, 2007; among many others) On the other hand, large firms tend to hedge more than small firms, which might reduce the exposure. There are less hedging costs for larger corporations because of economies of scale, and thus more hedging activities are associated with less exposure. (See, for example, Allayannis & Ofek, 2001; Nance, et al, 1993; Hagelin & Pramborg, 2006; Bartram et al, 2009; among many others)

Secondly, leverage can be seen as a proxy for firms' incentive to hedge, and it has been suggested that it is also related to exchange rate exposure. There is also no coherent explanation of how financial leverage affects the currency exposure. On the one hand, firms with a greater level of debt in their capital structure are suggested to be more prone to financial distress and therefore this type of firms are more affected by foreign exchange rate movements. (See, for example, Francis et al, 2008; Aggarwal and Harper, 2010; Hutson and Stevenson, 2010; among many others)

However, there might be an inverse relation between leverage and exposure depending on hedging. It is suggested that firms with high level of debt are more inclined to hedge in order to reduce the earnings' volatility. (See, for example, He and Ng, 1998; Judge, 2006; Chue and Cook, 2008; among many others)

Thirdly, foreign sales ratio is found to be important in explaining various foreign exchange rate exposures in previous research, although recent studies found that even domestic firms face the same foreign exchange rate risk as multinationals due to huge imports (Aggarwal & Harper, 2010). Firms can be classified into four types by their international activities including importing-only, exporting-only, both importing and exporting or neither. It is interested to investigate the relationship between firms' international activities and foreign exchange exposure. Since the majority of UK firms employ both importing and exporting activities, it is ideal to include both imported inputs and foreign sales as a proxy for international activities for firms. However, the imported inputs data for UK firms is unavailable, and foreign sales ratio is usually employed to proxy for international activities in the literature. Therefore, the results based on foreign sales ratio alone need to interpret with caution. Furthermore, the impact of foreign sales ratio on firms' exposure is mixed. Many researchers claimed that there should be greater currency exposures for firms with higher levels of foreign sales. (See, for example, Jorion, 1990; Choi and Prasad, 1995; Allayannis & Ofek, 2001; Huffman, Makar and Beyer, 2010; among many others) However, there is also some evidence to demonstrate a negative relation between foreign sales and currency exposures because of hedging. (See, for example, Dominguez and Tesar, 2001; Allayannis, et al, 2001; Bodnar & Wong, 2003; Judge, 2006; among many others) Thus, this chapter will examine the impact of these three characteristics of firms on exchange rate pass-through.

In this chapter, we firstly build an empirical model for exchange rates pass-through into stock prices based on the implications in Chapter 3, with reference to a large quantity of panel data consisting of UK-listed nonfinancial firms observed during the period between 1990 and 2011. Given the dynamic process of stock prices and the endogeneity of transmission channels, a system GMM estimator (Arellano and Bond, 1991; Arellano and Bover, 1995) is used to study the exchange rate pass-through effect in this chapter. Furthermore, firms are divided into subgroups according to size, leverage and foreign sales ratio in order to examine the impact of firms' characteristics on exchange rate pass-through effects.

The empirical results found in this chapter demonstrate firstly the implications of the theoretical framework developed in Chapter 3. In other words, it is through earnings/cash flows and cost of capital that exchange rates affect companies' stock prices. More importantly, it is found that in general changes in exchange rates do not fully pass-through into stock prices, even if there is a more than complete pass-through effect of stock prices with regard to exchange rates, via revenue-side channel (earnings or cash flows) and via cost-side channel (cost of capital). It is interesting to note that the permanent effects on stock prices are greater than the transitory impacts. As a result, although the cost of capital channel can bear the brunt of the exposure by offering better investment opportunities, future investment opportunities are reduced and the net impact of exchange rates on stock prices is mainly determined by the permanent effect on wealth. In addition, it is also found that firms' characteristics can determine exchange rate pass-through effect. To be specific, size and foreign sales ratio are positively related to a firm's currency exposure, while the leverage ratio has a negative impact on the exchange rate pass-through effect.

This chapter shows the new findings with regards to the foreign exchange rate exposure in the literature. The contributions can be summarised as followings. Firstly, to the best of our knowledge, this chapter makes the first attempt to empirically examine the transmission channels through which the changes in exchange rates pass-through into stock prices. By taking the log-linear form of the theoretical framework developed in chapter 3, this study provides insight into how and why stock prices are affected by exchange rates. Second, this chapter studies further to examine the firm characteristics on the exchange rates pass-through effects. It contributes to the literature by showing the explanations why not all the firms are exposed to the exchange rates fluctuations to the same extent.

This chapter is organised as follows. Section 4.2 presents a discussion of the theoretical background and empirical specification. Section 4.3 provides detailed information about the sample, the variables used in this chapter and carries out a preliminary analysis. Section 4.4 describes the estimation and testing methods, as well as giving the baseline result for the whole dataset. Section 4.5 advances further to explore the impact of firms' characteristics on pass-through effect. Section 4.6 provides further robustness checks for the result. Section 4.7 concludes this part of the investigation.

4.2 Theoretical background and empirical specification

In this section, the theoretical background of the transmission channels through which the changes in exchange rates pass-through into stock prices will be reviewed, and then an empirical specification will be introduced which follows this theoretical framework. The empirical counterpart will be the baseline regression used in the following analysis.

Chapter 3 developed a theoretical model for changes in exchange rate pass-through into stock prices, based on share valuation models. It suggests that the mechanisms through which exchange rate variations affect stock prices can be ascertained in a simple framework, where pass-through is obtained from first differentiation of share value model with respect to exchange rates. Based on two popular share valuation models in the accounting literature including the Free Cash Flow model and the Residual Earnings model, it is suggested that exchange rate variations affect stock prices through the changes in both the cash flow (earnings) channel and the cost of capital channel.

According to Chapter 3, elasticity of stock prices, with respect to exchange rates, is given by:

$$\eta^{p,x} = \frac{\partial p_{it}}{\partial x_{it}} * \frac{x_{it}}{p_{it}} = \eta^{e,x} * \frac{e_{it}(e_{it}:x_{it})}{e_{it}(e_{it}:x_{it}) - B_{it} * g} - \eta^{r,x} * \frac{r_{it}(r_{it}:x_{it})}{r_{it}(r_{it}:x_{it}) - g} \tag{4.1}$$

Where $\eta^{e,x} = \frac{\partial e_{it}}{\partial x_{it}} * \frac{x_{it}}{e_{it}}$, $\eta^{r,x} = \frac{\partial r_{it}}{\partial x_{it}} * \frac{x_{it}}{r_{it}}$

$$\eta^{p,x} = \frac{\partial p_{it}}{\partial x_{it}} * \frac{x_{it}}{p_{it}} = \eta^{cfo,x} * \frac{cfo_{it}(cfo_{it}:x_{it})}{cfo_{it}(cfo_{it}:x_{it}) - ci_{it}(ci_{it}:x_{it})} - \eta^{ci,x} * \frac{ci_{it}(ci_{it}:x_{it})}{cfo_{it}(cfo_{it}:x_{it}) - ci_{it}(ci_{it}:x_{it})}$$
$$- \eta^{r,x} * \frac{r_{it}(r_{it}:x_{it})}{r_{it}(r_{it}:x_{it}) - g} \tag{4.2}$$

Where $\eta^{r,x} = \frac{\partial r_{it}}{\partial x_{it}} * \frac{x_{it}}{r_{it}}$, $\eta^{cfo,x} = \frac{\partial cfo_{it}}{\partial x_{it}} * \frac{x_{it}}{cfo_{it}}$, $\eta^{ci,x} = \frac{\partial ci_{it}}{\partial x_{it}} * \frac{x_{it}}{ci_{it}}$

The equations (4.1) and (4.2) are the overall stock price elasticities, with respect to an exchange rate based on the Free Cash Flow and Residual Earnings models respectively. In the equations, p refers to the stock prices, r is the cost of capital, e stands for companies' earnings, and cfo and ci are cash flows from operations and cash investments respectively, where all lowercase variables here are transformed into their logarithms. g is the stable growth rate, x means the exchange rates, and B_t refers to the book value of equity at time t. Moreover, we use e (e_t:x_t), r(r_t:x_t), cfo(cfo_t:x_t) and ci(ci_t:x_t) to stand for the corresponding channels, which will be affected by foreign exchange rates, according to Goldberg and Campa (2010). In addition, $\eta^{p,x}$, $\eta^{e,x}$, $\eta^{r,x}$, $\eta^{cfo,x}$ and $\eta^{ci,x}$ are the sensitivities of overall stock prices, earnings, cost of capital, cash flows from operations and cash investments respectively, with respect to foreign exchange rates. All these elasticities are defined as the partial differentiation of overall stock prices, earnings, cost of capital, and cash flows from operations or cash investments, with respect to exchange rates, respectively. This follows the work of Bartram, et al (2010), Goldberg and Campa (2010), among many others.

Based on the testable implications provided by this theoretical framework, for econometric analysis we specify the following dynamic equations for stock prices:

$$p_{it} = \alpha_i + \lambda_t + \pi^{r,x}(r_{it-1} * x_t) + \pi^{e,x}(e_{it-1} * x_t) + \beta_1 r_{it-1} + \beta_2 e_{it-1} + \beta_4 p_{it-1} + \mu_{it} \quad (4.3)$$

$$p_{it} = \alpha_i + \lambda_t + \pi^{r,x}(r_{it-1} * x_t) + \pi^{cf,x}(cf_{it-1} * x_t) + \beta_1 r_{it-1} + \beta_3 cf_{it-1} + \beta_4 p_{it-1} + \mu_{it} \quad (4.4)$$

These are the empirical counterparts of equations (4.1) and (4.2) respectively. Given the stationary of the annual exchange rate variable and all other variables, we choose a specification in levels instead of in first-differences. In equation (4.4), since there is a very high correlation between cash flow from operations and cash investments, we employ free cash flow instead in the model, to act as a proxy for them. x_t is the normal trade-weighted exchange rate, expressed as before in terms of number of foreign currency units per unit of domestic currency, therefore an increase in exchange rates means appreciation. In addition, p refers to stock prices, r is cost of capital, e stands for companies' earnings, and cf is free cash flows available for the company, which are measured as the difference between cash flow from operations and cash investments. Lower-case variables here refer to transformations into their logarithms.

If evaluating the implications for firms' stock prices of exchange rate swings, the essential elements are the two interaction terms. As shown in equation (4.3), based on the Residual Earnings model, the key elements are the two interaction terms in the exchange rate which are, respectively, r_{it-1}, cost of capital, and e_{it-1}, companies' earnings. In order to mitigate the possible simultaneity bias arising from the impact of exchange rate variations on companies' operation, both possible channels are lagged by one period. In a similar way to equation (4.3), the Free Cash Flow model implies that the interaction terms of the exchange rate are, respectively, r_{it-1} the cost of capital, and cf_{it-1} the companies' free cash flows, both also lagged by one period, as shown in equation (4.4). Whichever theoretical model is employed, two types of interaction items are suggested, and this reflects firms' exposure to international competition in cost side (r_{it-1}) and revenue side (e_{it-1} or cf_{it-1}), respectively. By interacting the exchange rate, x_t, with these firm-specific, time-varying variables, this empirical specification allows the effect of the exchange rate on stock prices to vary over time and across firms, depending on the possible transmission channels identified in the theoretical framework. In addition to the interaction terms, cost of capital and earnings (free cash flows) are also inserted in the specification as single repressors. These two variables in isolation are included, following the example of Nucci & Pozzolo (2010), in order to ascertain whether a significant coefficient in the interaction terms reflects the currency impact via firm' channel, rather than the impact of any channel itself.

Moreover, to control the price adjustment process, a lagged value of the dependent variable is included in the equation, since there is empirical evidence for the mean reversion in stock prices. In addition, the fixed effect α_i for firms is included to allow for firm-specific heterogeneity, and also time varying effects λ_t. The error terms of the specification above, μ_{it}, are assumed to have zero mean and to be uncorrelated with each other as shown by $E(\mu_{it})=E(\mu_{it}\ \mu_{is})=0$, for all $t \neq s$.

4.3 Data and preliminary analysis

4.3.1 Data and summary statistics

The empirical specification is estimated using all UK non-financial firms with data available for the period 1990-2011. Data from financial companies is excluded since they encounter different foreign exchange rate exposure to other firms due to heavy regulation, which is constantly shown in research, such as that by Bartram (2007), Aggarwal & Harper (2010), among many others. The sample period we analyse begins in 1990, when the trade-weighted exchange rate for sterling calculated by the Bank of England became available.

In developing our sample, we begin with all UK-listed non-financial firms from the Worldscope database. Then we remove firms with negative net income, because of the assumption in the stable growth model of share valuation models. We further exclude firms with either negative free cash flows or no cash flow data, since the Free Cash Flow mode requires positive free cash flows to value equity. In addition, to be included in the sample, firms must have a continuous operating history over the past five years, and thus meet the accounting rules of "Going concern". This narrows the sample to 421 UK-listed non-financial firms with five to 20 years financial records, and around 3515 observations in total.

Table 4.1: Summary of main variables used in Chapter 4

Variables	Measurement
Stock price (p)	Closing price for stock.
Exchange rate (x)	Both nominal and real trade-weighted exchange rate calculated by the Bank of England.
Cost of equity (r)	Implied cost of capital using the Gordon Growth Model.
Earnings (e)	Net income after taxes and interests in the income statement.
Free cash flow (cf)	The difference between cash flows from operations and cash investments in cash flow statement.
Firm size (sz)	The book value of total assets in their logarithms.
Leverage ratio (lev)	The ratio of book value of total debt to total common equity in balance sheet.
Foreign sales ratio (fs)	The ratio of book value of foreign sales to total sales.

Notes:

1. The definitions and measurements are based on existing literature.

2. Trade-weighted exchange rates are obtained from the Bank of England website.
3. Cost of equity is calculated from equation (4.5), and the data used for calculation is obtained from the Worldscope database.
4. Stock price, earnings, free cash flows, total assets, leverage ratios and foreign sales ratios are collected from the Worldscope database via Thomas one Banker analytics.

This chapter attempts to investigate why certain types of firm face significant foreign exchange rate exposures while the others do not. In other words, based on the pass-through channels through which changes in exchange rate affect the stock prices identified in Chapter 3, this section will further examine the impact of firms' characteristics on exchange rate pass-through into stock prices. Using the research summarised in Chapter 2, three types of characteristic are tested. The first is size of firm, which, it is suggested, is measured by logarithms of total assets. The second is firms' financial leverage, measured by gearing ratio (total debt divided by total equity) in this chapter. The final one is foreign sales ratio for a firm. The percentage of foreign sales relative to total sales is used to measure firms' openness. Higher foreign sales as the average ratio of total sales indicate greater openness in firms. The impact of these three factors is ambiguous due to the hedging activities used by different companies.

As seen from Table 4.1, all the firm-level data including net income, stock prices, total assets, free cash flows, foreign sales ratio, total debt and total equity are collected from the World scope database via Thomas one banker analytics. In terms of exchange rate, the trade-weighted rate calculated by the Bank of England is obtained from its website. In addition, due to a lack of data on firms' cost of capital, as suggested by Easton (2004), Lee, Ng and Swaminathan (2009), among many others, we adopt implied cost of capital in this chapter. Since all the firms in this sample are mature, the Gordon Growth Model can be employed to calculate the cost of capital for each firm, as the following equation shows, which is the same as the one in Chapter 3.

$$stockprice = \frac{dividend}{\cos tofcapital - stablegrowrate} \qquad (4.5)$$

Table 4.2 documents some descriptive statistics for the variables used in our empirical analysis, where Panel A tables the summary statistics of the original data and Panel B presents the data after winsorisation. It can be seen that after winsorisation, the extreme values in the sample disappear, especially for some firm-specific variables such as stock prices, cost of capital, companies' earnings and free cash flows. Since the winsorisation means that the data above the top 99^{th} percentile and below the bottom 1^{st} percentile are set as equal to their 99^{th} percentile and 1^{st} percentile values respectively, as well as keeping the others unchanged, this transformation will be beneficial in reducing potential estimation bias due to outliers, while making full use of observations as well. Therefore, our results are based on the winsorised variables.

Table 4.2: Summary statistics

Variable	Mean	Std.	Min.	p25	Median	p75	Max
Panel A: Summary statistics of main variables without winsorisation							
p	0.6368	1.2242	-5.3817	-0.0780	0.6850	1.4207	5.0641
X_1	4.5392	0.0973	4.3330	4.4345	4.5800	4.6095	4.6490
X_2	4.5544	0.0863	4.3631	4.4517	4.5849	4.6266	4.6529
r	0.0888	0.0273	0.0288	0.0717	0.0847	0.1026	0.4453
e	16.2175	2.2543	6.9078	14.7063	16.0836	17.6891	22.9537
cf	15.7564	2.2414	3.5835	14.2890	15.6561	17.2167	22.8018
$r_{it-1}*x_{1t}$	0.3897	0.1175	0.1266	0.3148	0.3736	0.4491	1.9748
$e_{it-1}*x_{1t}$	74.4148	10.4056	32.114	67.2851	73.7635	81.3239	104.570
$cf_{it-1}*x_{it}$	72.5044	10.2234	36.0995	65.5749	72.0606	79.4056	100.974
Panel B: Summary statistics of main variables winsorised at the top and bottom 1st							
p	0.6409	1.1895	-2.6956	-0.0780	0.6850	1.4207	3.3702
X_1	4.5392	0.0973	4.3330	4.4345	4.5800	4.6095	4.6490
X_2	4.5546	0.0859	4.4014	4.4517	4.5849	4.6266	4.6529
r	0.0885	0.0253	0.0288	0.0717	0.0847	0.1026	0.1764
e	16.2242	2.2131	11.0562	14.7063	16.0836	17.689	21.8162
cf	15.7603	2.2005	10.4043	14.2890	15.6561	17.2167	21.0753
$r_{it-1}*x_{1t}$	0.3886	0.1102	0.1266	0.3148	0.3736	0.4491	0.8165
$e_{it-1}*x_{1t}$	74.4439	10.2138	48.6158	67.2851	73.7635	81.3239	101.423
$cf_{it-1}*x_{it}$	72.5077	10.0757	45.7492	65.5749	72.0606	79.4056	97.9791

Notes:

1. The lowercase refers to the logarithms of the original data. p is stock prices, x_1 is the nominal trade-weighted exchange rate for sterling, x_2 is real trade-weighted exchange rate for sterling, r is the cost of capital for the firm, e is the companies' net income, cf is the free cash flows for the firm. $r_{it-1}*x_{1t,}$ is the interaction on the cost of capital side, $e_{it-1}*x_{1t}$ is the interaction on the earnings side, and $cf_{it-1}*x_{it}$ is the interaction on the cash flow side.
2. The time period is from 1990 to 2011, with 3135 observations in total.
3. Winsorisation is employed to deal with the extreme values of the original data. To be specific, all the data is the same as before, except that the data above the top 99^{th} percentile and below the bottom 1^{st} percentile are set to the 99^{th} percentile and 1^{st} percentile value, respectively.

Panel B in Table 4.2 shows that the average annual trade-weighted exchange rate is 4.54 (nominal) or 4.55 (real) during the sample period, and that the standard deviation is 0.97 for nominal trade-weighted exchange rates and 0.86 for real trade-weighted exchange rates. Stock price has a mean value of 0.64 with a standard deviation of 1.19. Interestingly, the distributions of both exchange rates and stock price are negatively skewed, as indicated by a lower mean value than median value. However, for cost of capital, companies' earnings and free cash flows, all follow a positively skewed distribution, since their mean values are bigger than the medians. The average free cash flows for a company are 15.76, which is a little lower than the net income (16.22). The volatility of free cash flows and earnings are the most significant among all the variables, as suggested by the highest standard deviations for these two variables. In terms of cost of capital, the firms in our sample require 8.85% return on average, with around 7% for the first quartile and more than 10% for the third quartile. For the interaction items, free cash flow-side interaction terms have similar distribution to net income-side interaction items, with a slightly lower value on the mean, the 25^{th} percentile and the 75^{th} percentile, and exhibit a lower degree of variability, as suggested by the lower value of standard deviation. The mean of cost of capital side interaction items is 0.3886 with a standard deviation of 0.1102. However, there is limitation in these data. Due to the assumptions in share valuation models in research on accounting, this dataset reflects to a considerable extent the fact that firms are healthy and mature firms.

Table 4.3 shows the pair-wise correlation matrix of all the variables. As expected, the interaction items of transmission channels and exchange rates are highly related to the transmission channels themselves. However, in order to ascertain whether a significant coefficient in the interaction terms reflects the firm’s channel effect rather than the impact of exchange rate movements, the isolated variables should be included in the regression. Moreover, there is a high and positive correlation coefficient between free cash flows and earnings. There is no significant evidence of near multicollinearity shown in this correlation matrix.

Table 4.3 Correlation coefficient matrix

	p_t	x_{1t}	x_{2t}	p_{t-1}	r_{t-1}	e_{t-1}	cf_{t-1}	$r_{it-1}*x_{1t}$	$e_{it-1}*x_{1t}$	$cf_{it-1}*x_{1t}$
p_t	1.00									
x_{1t}	0.09	1.00								
x_{2t}	0.09	0.98***	1.00							
p_{t-1}	0.93***	0.01	0.01	1.00						
r_{t-1}	-0.01	-0.00	-0.00	0.01	1.00					
e_{t-1}	0.63***	-0.04*	-0.05*	0.66***	0.05**	1.00				
cf_{t-1}	0.57***	-0.04*	-0.07***	0.58***	-0.03	0.87***	1.00			
$r_{it-1}*x_{1t}$	-0.09	0.07**	0.07**	0.01	0.10***	0.05*	-0.03	1.00		
$e_{it-1}*x_{1t}$	0.63***	0.11***	0.09***	0.66***	0.05**	0.99***	0.86***	0.06**	1.00	
$cf_{it-1}*x_{1t}$	0.57***	0.10***	0.07***	0.57***	-0.03	0.86***	0.99***	-0.02	0.87***	1.00

Notes:

1. The correlation matrix is based on the sample during the period 1990 to 2011 for UK firms.
2. The pair-wise Pearson correlation coefficients between corresponding variables are presented in each cell.

3. p is stock prices, x_1 is nominal trade-weighted exchange rate rates, x_2 is real trade-weighted exchange rates, r is cost of capital, e is companies' earnings, cf is free cash flows to the firm, $r_{it-1}*x_{1t}$ is the interaction items on the cost side, $e_{it-1}*x_{1t}$ and $cf_{it-1}*x_{1t}$ are the interaction items on the revenue side.
4. * Significant at the 10% level; ** significant at the 5% level; ***significant at the 1% level.

4.3.2 Preliminary analysis of endogeneity

Endogeneity is an essential problem in empirical studies. Roberts and Whited (forthcoming) claim that biased and inconsistent estimators will be obtained because of endogeneity, which can lead to unreliable inference. Therefore, this section will check endogeneity before estimating the regressions.

In the residual earnings and free cash flow equations, although cost of capital and earnings or free cash flows are lagged by one period, due to possible simultaneity bias owing to the impacts of changes in exchange rates on these two items, there may also be some omitted unobserved variables in the error term. The cash flows, earnings and cost of capital might be also affected by these omitted unobserved variables, such as management, culture, etc. which cause endogeneity. Thus, we employ an advanced endogeneity test developed by Baum et al. (2007) to these two kinds of variables in the regressions. This test assumes that specified endogenous variables can be treated as exogenous, and the test statistics follow a chi-square distribution with degrees of freedom equal to the number of regressors tested in the equation. This test is mathematically equal to a Hausman test under conditional homoskedasticity. However, these test statistics, which are defined as the difference of two Sargan-Hansen statistics, are more advanced as they are more robust in the face of various violations of conditional homoskedasticity.

Table 4.4 shows the endogeneity tests results for the residual earnings and free cash flow equations, respectively. In the residual earnings equation, cost of capital and companies' earnings, both of which are lagged by one period, are treated as endogenous variables, while in the free cash flow equation, the endogenous variables tested are cost of capital and free cash flows. In the test, the first differences of the variables are used as instrument variables, since the Hansen test and Difference-in-Hansen test confirm the validity of these instruments.[8] In other words, the first differences of the endogenous variables are highly related to the endogenous variables themselves but not related to the error term. Both test results reject the null hypothesis that they can be treated as exogenous. In other words, there is significant evidence to show the endogeneity of these two kinds of regressors in the equation. Therefore, the endogeneity problem should be considered in these regressions, in order to provide unbiased and consistent estimation and reliable inferences of the exchange rate pass-through effect.

[8] See Hansen test and Difference-in-Hansen test in Table 4.5.

Table 4.4 Endogeneity tests

	Residual earnings equation	Free cash flows equation
Regressors tested	r_{it-1}; e_{it-1}	r_{it-1}; cf_{it-1}
Instrumental variables used	Δr_t; Δe_t	Δr_t; Δcf_t
Endogeneity test statistics	376.304***	273.114***

Notes:

1. We employ the first difference as an instrumental variable for the endogenous variables in the regression.
2. The endogeneity test employed here is developed by Baum et al. (2007). The null hypothesis is that the specified endogenous regressors can actually be treated as exogenous. The test statistics are calculated as the difference of two Sargan-Hansen statistics: one for the equation with the smaller set of instruments, where the suspect regressor(s) are treated as endogenous, and one for the equation with the larger set of instruments, where the suspect regressors are treated as exogenous, and follows a chi-squared distribution with degrees of freedom equal to the number of regressors tested. This endogeneity test statistic is numerically equal to a Hausman test statistic under conditional homoskedasticity, but these test statistics are robust to various violations of conditional homoskedasticity as well. The p-value of the test statistics is reported in the parenthesis underneath.

4.4 Empirical results

In this section, we will present the results of the empirical specification discussed in Section 4.3, which provides a suitable framework for examining the verifiable implications of our theoretical model in Chapter 3.

Equations (4.3) and (4.4) are baseline equations, based on the residual earnings and free cash flow models respectively. The generalized method of moments (GMM) estimator developed for the dynamic panel data model is employed to estimate these two regressions because of the endogeneity and dynamic structures. More specifically, the reason why we rely on this methodology is that, in the specifications above, the lagged values of the dependent variable, of cost of equity, and of companies' earnings or free cash flows are correlated with the individual fixed effect α_i. This would yield inconsistent parameters if standard panel estimators were used, when consistency can be restored by controlling the endogeneity of the regressors by GMM technique. We use the system GMM panel estimator suggested by Arellano and Bover (1995), and select the first-difference values of the dependent variable dated period t-1 and earlier as GMM-type of instruments suggested by this approach. Furthermore, neither one-step fix model nor two-stage least square estimation can be employed to deal with this kind of endogeneity. For one-step fix model, bias will arises as a result of correlation between regressor and error when demeaning. For two-step least square estimation, although consistent estimation can be obtained, it fails to take all of the potential orthogonality conditions into account. Therefore, the coefficient on lagged values of dependent variable is outside the bounds of its OLS and FE counterparts, and much larger than unity, a value consistent with dynamic stability. In order to consider both dynamic process and endogeneity, system-GMM estimator is suggested to be superior to the other estimation methods. In addition, before using the system-GMM estimators, we need to choose between one-step and two-step estimation techniques. Two-step estimators are developed to generate heteroscedasticity-consistent standard errors. That is to say, two-step estimators are expected to be more efficient than one-step estimators but as an expense at downward biased in finite-sample regressions. Therefore, we employ two-step system-GMM estimators with finite-sample correction to estimate the equations (4.3) and (4.4).

In addition, we also employ several tests for the validity of the instruments and the robustness of the specifications. The first is Hansen's J test of over-identifying restrictions to test the instrument's exogeneity. Next, the Arellano-Bond test for first-order and second-order serial correlation is performed based on residuals from the transformed equation. In addition, a crisis dummy is included for the ongoing financial crisis. We set the crisis dummy equal to one when the year is 2008 and afterwards, otherwise it is zero.

Table 4.5 reports the estimation and test results for the residual earnings and free cash flow equations, respectively. Generally, it can be seen that econometric results support the view that exchange rate fluctuations have a significant impact on stock prices. Column (1) shows the estimation result based on the residual earnings model from regression equation (4.3), while column (2) is the result based on the free cash flow model from estimating equation (4.4). In both regressions, the coefficient measuring the effect of exchange rate through changes in the proceeds from cost of capital is always positive, and is significantly different from zero at the 95% confidence level and 99% level for the Residual Earnings and Free Cash flow models respectively. In terms of estimated coefficient measuring the impact through changes in earnings, using either firm's net income (suggested by the Residual Earnings model) or firm's cash flows (suggested by the free cash flow model) is always negative and significantly different from zero at the 99% confidence level. Therefore, these empirical results confirm two kinds of transmission channel for exchange rate pass-through effect: one is the cost of capital channel and the other is the earnings channel. Exchange rate depreciation, as measured by a reduction of trade-weighted exchange rate, induces a stock price increase through the revenue-side channel (earnings or free cash flows) and a decrease through the cost-side channel (cost of capital). Furthermore, the effect stemming from the cost of capital side increases, in absolute value, as a result of a higher cost of capital for a firm, while the effect through the earnings channel increases with the growing net income or cash flows for a firm.

The signs and magnitudes of the other parameters estimated from our baseline specification also make sense. The previous cost of capital has a negative impact on the stock prices, significantly at 5% and 1% level for the Residual Earnings model and Free Cash Flow model respectively. Similarly, the coefficient of the lagged dependent variable, which accounts for possible persistence in the stock prices, is positive and statistically significant. Moreover, we include one control variable for the financial crisis. The dummy variable (crisis) stands for today's worldwide financial crisis, which began in 2008. The estimated coefficient suggests that the financial crisis has a strongly negative impact on UK equity prices.

Table 4.5 Baseline result for exchange rate pass-through effect

	Residual earnings	Free cash flow equation
$e_{it-1}*x_t$	-0.127***	
	(0.0331)	
$cf_{it-1}*x_t$		-0.152***
		(0.0315)
$r_{it-1}*x_t$	13.88**	16.75***
	(5.857)	(5.435)
e_{it-1}	0.614***	
	(0.151)	
cf_{it-1}		0.739***
		(0.144)
r_{it-1}	-62.52**	-74.58***
	(26.01)	(24.14)
p_{it-1}	0.345***	0.381***
	(0.0487)	(0.0444)
crisis	-0.350***	-0.391***
	(0.0493)	(0.0520)
Arellano-Bond test for AR(1) in first differences	-5.079	-5.339
	(p=0.000)	(p=0.000)
Arellano-Bond test for AR(2) in first differences	0.0657	0.0540
	(p=0.948)	(p=0.957)
Hansen test of over-identifying restrictions	315.9	313.9
	(p=0.998)	(p=0.999)
Difference-in-Hansen tests of exogeneity of instrument subsets	3.81	0.11
	(p=0.283)	(p=0.991)

Instruments used	$\Delta e_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	192.9***	243.3***
No. of observations	2240	2238

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990 - 2011. The residual earnings equation and free cash flow equation are specified in equation (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11.
2. r_{it-1} is the cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is nominal trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we control for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008 and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.
3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the free cash flows equation.

4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics is that they can be greatly weakened by the use of so many instruments.
6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

The magnitude of the effects through the cost of capital channel and the earnings/free cash flows channel are also displayed in Table 4.5. By evaluating cost of capital and earnings at their median value, the net elasticities of stock prices with respect to exchange rate variations, estimated through equations (4.3) and (4.4) would be -0.867 for the residual earnings model and -0.961 for the free cash flow model respectively. Hence, the residual earnings model suggests that a 1% depreciation of exchange rate should lead to a 0.867% increase in stock prices for a hypothetical firm exhibiting these median values. Similarly, the free cash flows model suggests a 0.961% increase in stock prices due to 1% depreciation in trade-weighted exchange rates, which is a little higher than implied by the residual earnings model. However, there may be significant differences in the direction and size of the response at the level of the firm, due to earnings, free cash flows and cost of capital across various firms. For example, based on the residual earnings model, for a firm at the 25th percentile, a 1% depreciation in exchange rate determines a 1.868% increase in stock prices through the earnings channel and a 0.995% decrease through the cost of capital channel, with net effect of equity price growing by 0.873%. For a firm at 75th percentile, a 1% depreciation in exchange rate results in a 2.247% increase in stock prices through the net income channel and a 1.424% decrease through the cost of capital channel, with a net impact of a 0.823% increase. A similar pattern can be found based on the free cash flows model in equation (4.4). Generally speaking, channel effects are increasing functions of earnings, free cash flows and cost of capital, but the net elasticities decreased as a result of growing earnings, free cash flows and cost of capital.

The fact that the significant coefficients associated with the transmission channels have the expected signs and magnitudes is important for research. Firstly, although the net effect of changes in exchange rates on stock prices is a little less than 100% full pass-through, there is a higher than full pass-through effect in both the revenue-side channel (earnings and free cash flows) and the cost-side channel (cost of capital). If we look at the implications for the residual earnings model, for example, a 1% depreciation in trade-weighted exchange rates causes a 2.043% increase through the earnings channel, and a 1.176% decrease through the cost of capital channel. Furthermore, the revenue-side channel (earnings or free cash flows) always performs as a negative transmission channel, while impact through the cost-side channel (cost of capital) is always positive. That is to say, higher trade-weighted exchange rates will decrease companies' sales since the selling price will be higher in foreign countries, thus lowering the firms' earnings and free cash flows. At the same time, these growing trade-weighted exchange rates will be beneficial in terms of providing better investment opportunities in the future by increasing future excess returns. Last but not least, the coefficients associated with the earnings or free cash flows channel are always larger than in the cost of capital channel, suggesting that permanent "bad" effects outweigh the transitory "good" effects. In other words, foreign exchange exposure via the revenue-side channel tends to outweight the effect via the cost of capital channel, so that future investment opportunities are reduced. These findings are consistent with Campbell and Vuolteenaho (2004) based on market-level data for the US.

In addition, all the diagnostic tests results here suggest the validity of our specification. Specifically, the values from the Wald test show the significance of all the variables employed in the regression. Furthermore, the Arellano-Bond test shows the existence of first-order serial correlation and an absence of second-order serial correlation of residuals, as expected, indicating a well-specified model. Thus, our instruments are proved to be valid by the Hansen statistics for over-identifying restrictions.

4.5 Firm-level Determinants

Our approach is particularly suitable for capturing transmission channels at the firms' level, since it allows for firm-specific, time-varying effects. Therefore, as an extension, this section will analyse the effects of firms' characteristics on transmission channels. Although our baseline regressions confirm the two transmission channels identified in our theoretical framework, due to the unique characteristics of various firms, there may be significant differences in the impact of exchange rates on stock prices through each channel for different firms. In particular, research has suggested that while some firms face significant exposure to positive or negative exchange rates, some are not significantly exposed to foreign exchange rate risks. This section will employ three characteristics of firms suggested by research, to illustrate how and why this has happened.

4.5.1 Size

Table 4.6 Exchange rate pass-through effect: the role of size

	Large-sized firms	**Small-sized firms**
Panel A: Residual earnings equation		
$e_{it-1}*x_t$	-0.107***	-0.0978*
	(0.0362)	(0.0591)
$r_{it-1}*x_t$	7.308	12.73
	(6.360)	(8.934)
e_{it-1}	0.516***	0.530*
	(0.164)	(0.272)
r_{it-1}	-33.25	-58.97
	(28.18)	(39.64)
p_{it-1}	0.385***	0.226***
	(0.0542)	(0.0693)
crisis	-0.360***	-0.314***
	(0.0597)	(0.0713)
Arellano-Bond test for AR(1) in first differences	-3.897	-3.389
	(p=0.000)	(p=0.001)
Arellano-Bond test for AR(2) in first differences	-0.253	0.627
	(p=0. 800)	(p=0.531)
Hansen test of over-identifying	199.9	194.1

restrictions	(p=1.00)	(p=0.999)
Difference-in-Hansen tests of exogeneity of instrument subsets	-0.26	4.33
	(p=1.00)	(p=0.115)
Instruments used	$\Delta e_{t-1,\ldots t-19}$	$\Delta e_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	168.5***	101.1***
No. of observations	1217	1023
Panel B: Free cash flows equation		
cf_{it-1}*x_t	-0.133***	-0.109*
	(0.0334)	(0.0566)
r_{it-1}*x_t	10.98*	13.03
	(5.655)	(7.949)
cf_{it-1}	0.666***	0.545**
	(0.152)	(0.254)
r_{it-1}	-48.80*	-59.78*
	(25.03)	(35.01)
p_{it-1}	0.397***	0.293***
	(0.0515)	(0.0803)
crisis	-0.407***	-0.310***
	(0.0634)	(0.0697)
Arellano-Bond test for AR(1) in first differences	-4.051	-3.452
	(p=0.000)	(p=0.001)

Arellano-Bond test for AR(2) in first differences	-0.576 (p=0.565)	0.657 (p= 0.511)
Hansen test of over-identifying restrictions	198.8 (p=1.000)	191.9 (p=1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	2.53 (p=0.282)	1.36 (p=0.507)
Instruments used	$\Delta cf_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	181.4***	372.5***
No. of observations	1215	1023

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990—2011. The residual earnings equation and the free cash flow equation are specified in equation (4.3) and (4.4) respectively, and estimated using the system GMM two-step panel estimator by STATA 11. Firms are divided into large and small size groups according to their median values of total log assets. Firms whose total assets are higher than their median value are defined as large; all others are seen as small.
2. r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is nominal trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we control for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and

serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.

3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for free cash flows equation.
4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for this test statistics is that it can be greatly weakened by so many instruments.
6. The Difference-in-Hansen test is employed for the validity of the subsets of the instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

Table 4.6 presents estimation results based on different sized companies. We divided the firms into large sized groups, whose total assets are higher than their median value, and small sized companies where total assets are lower than median value. Panel A in

Table 4.6 shows the effect of exchange rate fluctuations on stock prices suggested by the residual earnings model, and the results based on the free cash flow model is presented in Panel B. Panel A clearly shows a much more significant effect through the earnings channel for large firms than for small ones, since the coefficient associated with the interaction term ($e_{it-1}*x_t$) for large firms is significant at a 99% confidence level, while it is only at 90% for small firms, based on the Residual Earnings model. Furthermore, the magnitude of the channel effect also shows the difference between large and small companies. There is relatively greater impact through the earnings channel, and higher net elasticity, although the effect via cost of capital is not significant for large companies. For example, for large firms exhibiting their median values, a 1% depreciation results in a 1.26% increase for stock prices via the impact on companies' earnings and cost of capital. However, smaller firms only experience a 0.39% increase as a result of 1% currency depreciation, which is only one third of that in larger companies. This is consistent with the fact that large firms are more internationally orientated and are more exposed to foreign exchange rates. (See, for example, He and Ng, 1998; Bartram, 2007; among many others) But this finding is somewhat at odds with research on hedging. Previous literature suggests little effect of exchange rates on stock prices with regard to relatively large companies, for two reasons. Firstly, large companies may allocate their resources all over the world, which can operationally diverse foreign exchange rate risk. Secondly, there tend to be more sophisticated hedging techniques in large firms. However, our results do not find evidence that hedging reduces exposure in larger companies. The reasons might be as follows: hedging is not helpful; the companies in our sample do not employ many hedging activities; there is no significant evidence for the relation between size and hedging activities; or other reasons.[9]

Panel B presents how the stock prices of different sized companies are affected by exchange rate fluctuations based on the free cash flow model. Similarly, it also suggests that larger firms will experience greater effects through the cash flow channel, as indicated by the less significant coefficient associated with the $cf_{it-1}*x_t$ for small firms. Moreover, it also finds a significant impact via the cost of capital channel for large firms, while the coefficient for smaller ones does not vary significantly from zero. Additionally, Panel B also confirms that both channel effects and net exchange rate exposures are greater for larger companies than for smaller ones. For example, if the trade-weighted exchange rate for sterling increases by 1%, the stock prices of UK firms exhibiting their median values with higher total assets will decrease by 1.34%, while smaller firms only exhibit a 0.5% decrease.

In conclusion, for larger firms, both the earnings (cash flow) and cost of equity channels show much more pass- through of exchange rate fluctuations into stock

[9] Due to data limitation, the exact explanation for the positive relation between firm size and currency exposure cannot be given.

prices than is the case with smaller ones. Moreover, there is also a higher pass-through effect and a greater currency exposure for larger firms than smaller ones. Previous research found mixed results for this issue. These findings add more detailed evidence about the positive relation between size of firm and exchange rate exposure as suggested by this previous research, such as that by He and Ng, 1998; Bartram, 2007; among many others, but we do not have evidence of reduced exchange rate exposures for larger companies, due to their greater hedging activities.

4.5.2 Leverage

Leverage can be seen as a proxy for the incentive to hedge, and research suggests that it is related to currency exposure. Therefore, this section tries to analyse the impact of leverage on exchange rate pass-through. In particular, we divide the firms into a high leverage group, whose debt-to-equity ratio is higher than its median value, and low leverage companies with a lower debt-to-equity ratio than median value. Table 4.7 shows results based on the residual earnings model in Panel A and free cash flow model in Panel B, respectively. From Panel A in Table 4.7, it can be seen that the exchange rate pass-through effects via the earnings channel and cost of capital channels are greater for lower leveraged firms than for higher leveraged ones. To be specific, for a hypothetical firm exhibiting their median values, the effect of a 1% depreciation on higher leveraged firms is almost -1.73% via the earnings channel and

1.02% via the cost of capital channel, thus making the net elasticity of stock prices with respect to the exchange rate almost -0.7%. However, for the lower leveraged firms, both channel effect and net exposure are higher. The stock prices of lower leveraged firms will increase by 1.11% due to a 1% depreciation. That is to say, while the changes in trade-weighted exchange rates will not fully pass-through into stock prices of higher leveraged firms, this effect will more than fully pass-through in low leveraged companies. This finding confirms the inverse relationship between leverage and currency exposure in research. Literature suggests that hedging activities are more valuable for firms with higher leverage ratio (See, for example, Nance et al., 1993; Judge, 2006; among many others), and thus the foreign exchange rate exposures of high leveraged firms are greatly reduced by the intensive usage of hedging activities. (See, for example, He and Ng, 1998; Chue and Cook, 2008; among many others)

Panel B of Table 4.7 presents the effect of leverage on the exchange rate pass-through effect, based on the free cash flow model. Firstly, it confirms that stock prices will be significantly affected by foreign exchange rates via both the cash flow channel and cost of capital, as the coefficients associated with $cf_{it-1}*x_t$ and $r_{it-1}*x_t$ are statistically significant. Furthermore, it confirms the facts found in the residual earnings model: lower leveraged firms will experience a higher pass-through effect and net impact of exchange rates than higher leveraged companies, although the free cash flow model suggests a higher level of exchange rate pass-through effect. Specifically, a 1%

depreciation will lead to a 0.71% increase for stock prices of higher leveraged firms, and a 1.23% increase for lower leveraged ones.

Table 4.7 Exchange rate pass-through effect: the role of leverage

	High-leveraged firms	Low- leveraged firms
Panel A: Residual earnings equation		
$e_{it-1}*x_t$	-0.101***	-0.148***
	(0.0374)	(0.0535)
$r_{it-1}*x_t$	12.04*	13.90
	(6.874)	(9.166)
e_{it-1}	0.488***	0.753***
	(0.173)	(0.243)
r_{it-1}	-54.66*	-64.39
	(30.51)	(40.81)
p_{it-1}	0.285***	0.242***
	(0.0719)	(0.0618)
crisis	-0.377***	-0.289***
	(0.0626)	(0.0696)
Arellano-Bond test for AR(1) in first differences	-3.144 (p= 0.002)	-3.314 (p= 0.001)
Arellano-Bond test for AR(2) in first	0.506	-0.482

differences	(p= 0.613)	(p= 0.630)
Hansen test of over-identifying	205.9	221.7
restrictions	(p= 1.000)	(p= 1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	1.83	0.94
	(p= 0.401)	(p= 0.625)
Instruments used	$\Delta e_{t-1,\ldots t-19}$	$\Delta e_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	105.2***	111.1***
No. of observations	1136	1104
Panel B: Free cash flows equation		
$cf_{it-1}*x_t$	-0.115***	-0.172***
	(0.0344)	(0.0533)
$r_{it-1}*x_t$	14.05**	15.93*
	(6.105)	(8.806)
cf_{it-1}	0.576***	0.829***
	(0.159)	(0.244)
r_{it-1}	-63.09**	-72.70*
	(27.07)	(39.15)
p_{it-1}	0.279***	0.312***
	(0.0656)	(0.0572)
crisis	-0.384***	-0.312***
	(0.0652)	(0.0713)

Arellano-Bond test for AR(1) in first differences	-3.272 (p= 0.001)	-3.633 (p=0.000)
Arellano-Bond test for AR(2) in first differences	0.198 (p= 0.843)	-0.309 (p= 0.757)
Hansen test of over-identifying restrictions	210.2 (p=1.000)	218.6 (p= 1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	0.50 (p= 0.779)	-0.71 (p= 1.000)
Instruments used	$\Delta cf_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	121.5***	132.1***
No. of observations	1135	1103

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990 - 2011. The residual earnings and free cash flow equations are specified in equation (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11. Firms are divided into a high and low leverage group according to their median values of Debt/Equity ratio. Firms whose debt/equity ratio is higher than their median value are defined as high leveraged firms; others are in the low leveraged group.
2. r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is nominal trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore,

we allow for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.

3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for the residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the free cash flows equation.
4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics is that they can be greatly weakened by the use of so many instruments.
6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

In conclusion, there is a negative relation between exchange rate pass-through effect and firms' leverage ratio. It is found that only 70% of changes in exchange rates will pass-through into stock prices of higher leveraged firms, while there is a greater than 100% currency pass-through effect for lower leveraged companies. The reasons are as follow: firms with a high level of debt in their capital structure are more prone to financial distress and therefore are more inclined to hedge in order to reduce the earnings' volatility. Therefore, foreign exchange rate exposure is significantly reduced for high leveraged firms. This negative relation is explained by hedging activities and is consistent with previous research. (See, for example, Nance et al., 1993; He & Ng, 1998; Judge, 2006; Chue & Cook, 2008; among many others)

4.5.3 Foreign sales

Table 4.8 examines how a firm's openness affects the impact of exchange rates on stock prices. Foreign sales ratio, measured by the average ratio of foreign sales to total sales, is employed to indicate a firm's openness. A higher foreign sales ratio stands for a more open firm. In other words, firms with more foreign sales are likely to be more open to the world economy. Similarly to previous sections, firms are divided into subgroups according to the median value of their foreign sales ratios: if higher than the median value they are recognized as high foreign sales firms, while all others are seen as low foreign sales firms.

Panel of Table 4.8 indicates the testable implications based on the Residual Earnings model. For exchange rate pass-through effect via the earnings channel, it suggests that there is a much more statistically significant and greater impact on less open companies than on more open. To be specific, a 1% depreciation leads to a 2% increase in stock prices through the changes in earnings for a hypothetical firm exhibiting the median value of the lower foreign sales group. However, there is only a 1% change in the higher foreign sales group. Furthermore, we should note that there is only significant evidence of this effect via cost of capital for less open firms. While the coefficient associated with $r_{it-1}*x_t$ is significantly at a 5% level for firms with a lower foreign sales ratio, it is not different from zero for firms with a higher foreign sales ratio. In other words, the cost of capital channel, which can bear the brunt of the exposure to some extent, only works for less open companies. Therefore, even exchange rates affect stock prices through a changes in earnings in less open firms as twice as for more open firms, the cost of capital channel for firms with a lower foreign sales ratio can reduce this impact greatly, leaving the net elasticity equal to -0.577% for them. Therefore, the overall impact of stock prices with respect to exchange rate for these less open firms is almost half the amount it is for more open ones. This positive relationship is consistent with previous research, such as Jorion (1990); Choi and Prasad (1995); Allayannis & Ofek (2001); Bartram (2007); Huffman, Makar and Beyer (2010); among many others.

Table 4.8 Exchange rate pass-through effect: the role of foreign sales ratio

	High foreign sales firms	Low foreign sales firms
Panel A: Residual earnings equation		
$e_{it-1}*x_t$	-0.0626*	-0.129***
	(0.0321)	(0.0462)
$r_{it-1}*x_t$	0.920	16.96**
	(6.686)	(8.375)
e_{it-1}	0.337**	0.604***
	(0.151)	(0.206)
r_{it-1}	-6.077	-75.56**
	(29.95)	(37.35)
p_{it-1}	0.640***	0.746***
	(0.0512)	(0.0452)
crisis	-0.253***	-0.382***
	(0.0551)	(0.0587)
Arellano-Bond test for AR(1) in first differences	-4.80	-4.39
	(p= 0.000)	(p= 0.000)
Arellano-Bond test for AR(2) in first differences	-0.42	1.27
	(p= 0.677)	(p= 0.205)
Hansen test of over-identifying	244.60	191.90

restrictions	(p=1.000)	(p=1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	1.02 (p= 0.602)	0.44 (p= 0.933)
Instruments used	$\Delta e_{t-1,\dots t-19}$	$\Delta e_{t-1,\dots t-19}$
	$\Delta r_{t-1,\dots,t-19}$	$\Delta r_{t-1,\dots,t-19}$
	$\Delta p_{t-1,\dots t-19}$	$\Delta p_{t-1,\dots t-19}$
Chi square-statistics for the equation	351.7***	508.8***
No. of observations	1314	926
Panel B: Free cash flows equation		
$cf_{it-1}*x_t$	-0.108***	-0.128***
	(0.0322)	(0.0469)
$r_{it-1}*x_t$	8.191	15.43*
	(6.337)	(8.074)
cf_{it-1}	0.580***	0.638***
	(0.15)	(0.212)
r_{it-1}	-37.14	-68.09*
	(28.33)	(35.99)
p_{it-1}	0.666***	0.732***
	(0.0417)	(0.0363)
crisis	-0.320***	-0.404***
	(0.0586)	(0.0581)
Arellano-Bond test for AR(1) in first differences	-4.88 (p=0.000)	-4.47 (p= 0.000)

Arellano-Bond test for AR(2) in first differences	-1.02 (p= 0.306)	1.49 (p= 0.135)
Hansen test of over-identifying restrictions	238.00 (p= 1.000)	194.52 (p= 1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	0.53 (p= 0.767)	3.28 (p= 0.350)
Instruments used	$\Delta cf_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	470.4***	666.6***
No. of observations	1313	925

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990- -2011. The residual earnings and free cash flow equations are specified in equations (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11. Firms are divided into high and low foreign sales groups, according to their median values of foreign to total sales ratio. Firms with a higher foreign to total sales ratio than their median value are defined as high foreign sales firms; all others are seen as low foreign sales firms.
2. r_{it-1} is the cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is nominal trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we allow for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008and is still ongoing.

Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.

3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the free cash flows equation.
4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics are that they can be greatly weakened by the use of so many instruments.
6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

Panel B of Table 4.8 presents the exchange rate pass-through effect based on the free cash flow model. Generally speaking, it confirms the findings suggested by the residual earnings model in Panel A of Table 4.8. The higher positive impact of fluctuations in exchange rates on stock prices via the cash flow channel can be greatly reduced by the notable negative effect via the cost of capital channel for less open firms, thus leaving the net elasticity of stock prices with regard to exchange rates as only -0.65 for this kind of firm. In contrast, there is no significant evidence to show the effect via cost of capital, only the cash flow channel effect for firms with a high level of foreign sales. Therefore, higher foreign sales ratio in a firm is associated with a greater exchange rate pass-through in general.

In conclusion, this section shows the positive relationship between foreign exchange exposure and foreign sales ratio. More open firms are more exposed to foreign exchange risks as research has suggested (See, for example, Jorion, 1990; Choi and Prasad, 1995; Allayannis & Ofek, 2001; Bartram, 2007; Huffman, Makar and Beyer, 2010; among many others). In addition, this section also provides detailed explanation as to why this has happened, based on the channel effect. The impact of the cost of capital channel to some extent bears the brunt of the exposure for the less open companies, thus reducing the net elasticity of their stock prices with regard to exchange rates.

4.6 Robustness Check

In order to check the robustness of our main results, further tests and estimations are employed in this section. Firstly, we examine whether one lag is enough to capture the dynamics process of stock prices. The model employed here is specified as follows:

$$p_{it} = \alpha_1 + \sum_{k=1}^{k=9} \beta_k p_{it-k} + \gamma Z_{it} + \mu_i + \varepsilon_{it} \quad (4.5)$$

p is stock prices, k is the length of the lags, and Z is a vector of all the control variables. The lower case here refers to their logarithms. Three model variants are employed in this analysis. Firstly, stock prices are regressed by their previous values only. Secondly, we employ earnings, cost of capital and the two exchange rate interaction items as control variables besides the stock prices' own lags, as suggested by the residual earnings model. The third model variant is to use free cash flows, cost of capital and the two exchange rate interaction items as control variables, as suggested by the free cash flow model. Appendix 3.A shows the estimation results. It is suggested that one lag of stock price should be enough to capture the dynamics process of stock prices, as indicated by the significant coefficient associated with the first lag of stock prices. Even the sixth lag is also significant; as the previous ones are insignificant and there is no theoretical and actual evidence for this phenomenon, one lag is found to be the best choice for this research.

Furthermore, real trade-weighted exchange rates are employed instead of nominal ones so that we can check the sensitivity of our findings to the choice of exchange rate measurements. Appendix 3.B confirms the findings in Section 4.4 with the nominal exchange rates. Although the channel effect is a little higher based on real exchange rates, it is also clear that currency depreciation will lead the stock prices to increase via the revenue-side channel and decrease via the cost-side channel. Moreover, the "bad" transit effects on earnings or cash flows outweigh the "good" permanent effects on the discounted rates.

The estimation results of subsamples based on real exchange rates are presented in Appendix 3.C, Appendix 3.D, and Appendix 3.E respectively. Generally speaking, size and openness are positively related to exchange exposures, while they are negatively affected by leverage, as expected. Overall, our findings are robust to different model specifications and variable measurements.

4.7 Concluding remarks

This chapter empirically investigates exchange rate pass-through effect into stock prices based on the theoretical framework developed in Chapter 3. In addition, this chapter provides more detailed information on the determinants of this pass-through effect, using a large panel of UK-listed non-financial companies. Based on both the Residual Earnings and the Free Cash Flow model, the findings can be summarized as follows.

Firstly, the implications of the theoretical framework in Chapter 3 have been demonstrated in this chapter. Although there is a low level of significant exchange rate exposure at firm-level in previous research, we have found that variations in exchange rates make significant impacts via the revenue-side and cost-side channels. That is to say, the fluctuations in exchange rates will have an impact on stock prices through changes in earnings or cash flows. At the same time, the stock prices will also be affected by changes in cost of capital. The impact of exchange rates on stock prices through these channels increases as a result of lower cost of capital, net income or free cash flows.

Secondly, while the revenue-side channel performs as a negative channel, the cost-side channel is a positive one. In other words, a decrease exchange rates leads to an increase in stock prices through their effect on earnings or cash flows, but to a decrease via the cost of capital channel. As a result, the cost of capital channel can bear the brunt of currency exposure by offering better investment opportunities in the future.

Thirdly, the “bad” transit effects outweigh the “good” permanent effects, as indicated by the coefficient associated with the revenue-side channel being larger than that with the cost-side channel. Therefore, the changes in stock prices as a result of fluctuations in exchange rates are due more to their impact on earnings or cash flows than on discounted rates. This suggests that the permanent impacts on stock prices are greater than the temporary effects on wealth, thus reducing future investment opportunities.

In addition, this chapter also examines the firm-level determinants of these exchange rate pass-through effects, including size, leverage and openness. It shows that there is a positive relationship between size and exposure, as well as between openness and exposure. Firms with higher total assets and a higher level of foreign sales tend to be more exposed to foreign exchange rate risks. However, leverage ratio is negatively related to currency exposure, since the firms with high level of debt are more inclined to hedge. Therefore, our results confirm the implications of the theoretical framework in Chapter 3, and offer new insights on the decomposition of exchange rate exposures, as well as providing firm-level determinants on exchange rate pass-through effects.

Appendix 4.A: Is one lag enough to capture the stock price dynamics

	Model variant (1)	Model variant (2)	Model variant (3)
Stock price(t-1) (p_{t-1})	0.544***	0.474***	0.478**
	(0.133)	(0.127)	(0.181)
Stock price(t-2) (p_{t-2})	0.0843	0.0962	0.128
	(0.162)	(0.154)	(0.159)
Stock price(t-3) (p_{t-3})	-0.148	-0.0744	-0.104
	(0.196)	(0.179)	(0.180)
Stock price(t-4) (p_{t-4})	0.434	0.309	0.349
	(0.261)	(0.231)	(0.230)
Stock price(t-5) (p_{t-5})	-0.0340	-0.0126	-0.0713
	(0.138)	(0.160)	(0.135)
Stock price(t-6) (p_{t-6})	0.329***	0.280**	0.312***
	(0.122)	(0.129)	(0.110)
Stock price(t-7) (p_{t-7})	-0.0237	0.0173	0.00807
	(0.160)	(0.120)	(0.118)
Stock price(t-8) (p_{t-8})	-0.237	-0.156	-0.169
	(0.156)	(0.104)	(0.128)
Stock price(t-9) (p_{t-9})	0.0831	0.0235	0.0298
	(0.121)	(0.0781)	(0.106)

Cost of capital (r)		-3.339**	-3.228**
		(1.567)	(1.337)
Earnings (e)		0.0709*	
		(0.0359)	
Free cash flows (cf)			0.0565
			(0.0408)
Cost of capital interaction (r_{it-1}*x_t)		-0.660*	-0.777**
		(0.390)	(0.347)
Earnings interaction (e_{it-1}*x_t)		-0.00746	
		(0.00760)	
Cash flow interaction (cf_{it-1}*x_t)			-0.00330
			(0.00796)
Observations	82	82	82
R^2	0.935	0.945	0.944
Adjusted R^2	0.927	0.935	0.933

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990- -2011. These three equations are estimated using the pooled OLS estimator with robust standard errors by STATA 11.
2. This table reports the estimation of this model:

$$p_{it} = \alpha_1 + \sum_{k=1}^{k=9} \beta_k p_{it-k} + \gamma Z_{it} + \mu_i + \varepsilon_{it}$$

p is stock prices, k is length of lags, Z is control variables. We employ three kinds of models: the first is the pure model without any control variables; the second one has control variables suggested by the residual earnings model; the third is the model with control variables suggested by the free cash flow model.

3. In this table, r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is nominal trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we allow for two financial crises during this sample period. Crisis 1 stands for the current financial crisis, which began in 2008and is still ongoing.
4. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.

Appendix 4.B: Estimation result for exchange rate pass-through effect with real exchange rate measurement

	Residual earnings equation	Free cash flow equation
$e_{it-1}*x_t$	-0.145***	
	(0.0330)	
$cf_{it-1}*x_t$		-0.171***
		(0.0324)
$r_{it-1}*x_t$	14.74**	17.62***
	(5.990)	(5.747)
e_{it-1}	0.698***	
	(0.151)	
cf_{it-1}		0.826***
		(0.148)
r_{it-1}	-66.26**	-78.40***
	(26.68)	(25.60)
p_{it-1}	0.360***	0.394***
	(0.0485)	(0.0449)
crisis	-0.387***	-0.427***
	(0.0517)	(0.0542)

Arellano-Bond test for AR(1) in first differences	-5.13 (p=0.000)	-5.36 (p=0.000)
Arellano-Bond test for AR(2) in first differences	0.19 (p= 0.847)	0.17 (p= 0.861)
Hansen test of over-identifying restrictions	315.01 (p=0.998)	312.29 (p=0.999)
Difference-in-Hansen tests of exogeneity of instrument subsets	3.99 (p= 0.262)	0.25 (p= 0.969)
Instruments used	$\Delta e_{t-1,\ldots t-19}$ $\Delta r_{t-1,\ldots,t-19}$ $\Delta p_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$ $\Delta r_{t-1,\ldots,t-19}$ $\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	200.8***	256.9***
No. of observations	2240	2238

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990- -2011. The residual earnings and free cash flow equations are specified in equations (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11.
2. r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is trade-weighted exchange rates measured by real exchange rates. All the variables in lower case indicate their

logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we allow for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008 and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.

3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for the residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the free cash flows equation.
4. The values of the Arellano-Bond test for first- and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics is that they can be greatly weakened by the use of so many instruments.
6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

Appendix 4.C: Estimation results of exchange rate pass-through effect with real exchange rates: the role of size

	Large-sized firms	Small- sized firms
Panel A: Residual earnings equation		
e_{it-1}*x_t	-0.123***	-0.124**
	(0.0349)	(0.0604)
r_{it-1}*x_t	7.403	15.22*
	(6.250)	(9.103)
e_{it-1}	0.586***	0.648**
	(0.159)	(0.278)
r_{it-1}	-33.48	-70.12*
	(27.77)	(40.47)
p_{it-1}	0.402***	0.235***
	(0.0561)	(0.0695)
crisis	-0.403***	-0.340***
	(0.0605)	(0.0743)
Arellano-Bond test for AR(1) in first differences	-3.91	-3.41
	(p=0.000)	(p=0.001)
Arellano-Bond test for AR(2) in first	-0.16	0.66

differences	(p=0.872)	(p= 0.508)
Hansen test of over-identifying	197.29	192.33
restrictions	(p=1.00)	(p=1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	-4.66	3.49
	(p=1.00)	(p=0.175)
Instruments used	$\Delta e_{t-1,\ldots t-19}$	$\Delta e_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	176.7***	102.7***
No. of observations	1217	1023
Panel B: Free cash flows equation		
$cf_{it-1}*x_t$	-0.150***	-0.140***
	(0.0328)	(0.0540)
$r_{it-1}*x_t$	11.34**	15.77**
	(5.589)	(7.890)
cf_{it-1}	0.741***	0.686***
	(0.150)	(0.247)
r_{it-1}	-50.24**	-72.06**
	(24.80)	(35.04)
p_{it-1}	0.412***	0.302***
	(0.0490)	(0.0655)
crisis	-0.448***	-0.344***

	(0.0648)	(0.0739)
Arellano-Bond test for AR(1) in first differences	-4.10 (p=0.000)	-3.54 (p=0.000)
Arellano-Bond test for AR(2) in first differences	-0.47 (p=0.636)	0.71 (p= 0.476)
Hansen test of over-identifying restrictions	201.63 (p=1.000)	195.12 (p=1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	3.75 (p=0.153)	0.96 (p=0.619)
Instruments used	$\Delta cf_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	208.8***	124.5***
No. of observations	1215	1023

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990- -011. The residual earnings and free cash flow equations are specified in equations (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11. Firms are divided into large and small size groups, according to their median value of log total assets. Firms whose total assets are higher than their median value are defined as large; all others are seen as small.

2. r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is real trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we allow for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008 and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.
3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the Free Cash Flows equation.
4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics is that they can be greatly weakened by the use of so many instruments.

6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

Appendix 4.D: Estimation results of exchange rate pass-through effect with real exchange rates: the role of leverage

	High-leveraged firms	Low-leveraged firms
Panel A: Residual earnings equation		
e_{it-1}*x_t	-0.120**	-0.166***
	(0.0481)	(0.0518)
r_{it-1}*x_t	13.10	14.60
	(12.58)	(9.018)
e_{it-1}	0.574***	0.831***
	(0.219)	(0.237)
r_{it-1}	-59.29	-67.49*
	(57.00)	(40.24)
p_{it-1}	0.298***	0.255***
	(0.0968)	(0.0628)
crisis	-0.414***	-0.321***
	(0.0664)	(0.0703)
Arellano-Bond test for AR(1) in first differences	-3.10 (p= 0.002)	-3.34 (p= 0.001)
Arellano-Bond test for AR(2) in first differences	0.56	-0.44

	(p= 0.575)	(p= 0.659)
Hansen test of over-identifying restrictions	211.81	219.87
	(p= 1.000)	(p= 1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	6.98	0.37
	(p= 0.030)	(p= 0.830)
Instruments used	$\Delta e_{t-1,\ldots t-19}$	$\Delta e_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	13643.6***	113.9***
No. of observations	1136	1104
Panel B: Free cash flows equation		
cf_{it-1}*x_t	-0.137***	-0.188***
	(0.0362)	(0.0524)
r_{it-1}*x_t	15.75**	16.19*
	(6.341)	(8.654)
cf_{it-1}	0.677***	0.902***
	(0.166)	(0.241)
r_{it-1}	-70.61**	-73.84*
	(28.18)	(38.53)
p_{it-1}	0.291***	0.322***
	(0.0665)	(0.0569)
crisis	-0.421***	-0.343***

	(0.0677)	(0.0733)
Arellano-Bond test for AR(1) in first differences	-3.28 (p= 0.001)	-3.68 (p=0.000)
Arellano-Bond test for AR(2) in first differences	0.33 (p= 0.743)	-0.30 (p= 0.767)
Hansen test of over-identifying restrictions	210.70 (p=1.000)	218.55 (p= 1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	2.21 (p= 0.331)	0.68 (p= 0.711)
Instruments used	$\Delta cf_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	137.9***	136.6***
No. of observations	1135	1103

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990 - 2011. The residual earnings free cash flow equations are specified in equations (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11. Firms are divided into high low leverage groups according to their median values of Debt/Equity ratio. Firms whose debt/equity ratio are higher than their median value are defined as high leveraged firms; all others are seen as low leveraged.

2. r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is real trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we allow for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.
3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the Free Cash Flows equation.
4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics is that they can be greatly weakened by the use of so many instruments.

6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

Appendix 4.E: Estimation results of exchange rate pass-through effect with real exchange rates: the role of foreign sales

	High foreign sales firms	Low foreign sales firms
Panel A: Residual earnings equation		
$e_{it-1}*x_t$	-0.0786**	-0.163***
	(0.0314)	(0.0528)
$r_{it-1}*x_t$	-2.478	19.19**
	(6.625)	(9.407)
e_{it-1}	0.401***	0.757***
	(0.148)	(0.238)
r_{it-1}	9.532	-85.72**
	(29.75)	(42.02)
p_{it-1}	0.661***	0.747***
	(0.0507)	(0.0447)
crisis	-0.332***	-0.431***
	(0.0603)	(0.0621)
Arellano-Bond test for AR(1) in first differences	-4.79	-4.36
	(p= 0.000)	(p= 0.000)
Arellano-Bond test for AR(2) in first	-0.23	1.38

differences	(p= 0.821)	(p= 0.166)
Hansen test of over-identifying	244.38	192.36
restrictions	(p=1.000)	(p=1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	3.14	5.96
	(p= 0.209)	(p= 0.114)
Instruments used	$\Delta e_{t-1,\ldots t-19}$	$\Delta e_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	395.7***	586.4***
No. of observations	1314	926
Panel A: Free cash flows equation		
$cf_{it-1}*x_t$	-0.128***	-0.160***
	(0.0319)	(0.0514)
$r_{it-1}*x_t$	5.552	17.21**
	(6.274)	(8.756)
cf_{it-1}	0.669***	0.783***
	(0.148)	(0.236)
r_{it-1}	-24.98	-76.20*
	(28.15)	(39.03)
p_{it-1}	0.683***	0.731***
	(0.0403)	(0.0334)
crisis	-0.403***	-0.453***

	(0.0643)	(0.0635)
Arellano-Bond test for AR(1) in first differences	-4.82 (p=0.000)	-4.45 (p= 0.000)
Arellano-Bond test for AR(2) in first differences	-0.81 (p= 0.418)	1.60 (p= 0.110)
Hansen test of over-identifying restrictions	237.42 (p= 1.000)	191.41 (p= 1.000)
Difference-in-Hansen tests of exogeneity of instrument subsets	0.84 (p= 0.659)	6.73 (p= 1.000)
Instruments used	$\Delta cf_{t-1,\ldots t-19}$	$\Delta cf_{t-1,\ldots t-19}$
	$\Delta r_{t-1,\ldots,t-19}$	$\Delta r_{t-1,\ldots,t-19}$
	$\Delta p_{t-1,\ldots t-19}$	$\Delta p_{t-1,\ldots t-19}$
Chi square-statistics for the equation	511.3***	713.2***
No. of observations	1313	925

Notes:

1. The sample contains all UK-listed non-financial firm-year observations for the period 1990 - 2011. The residual earnings free cash flow equations are specified in equations (4.3) and (4.4), respectively, and estimated using the system GMM two-step panel estimator by STATA 11. Firms are divided into high low foreign sales groups, according to their median values of foreign total sales ratio. Firms with a higher ratio of foreign sales to total sales ratio than their median value are defined as high foreign sales firms, otherwise the low foreign sales group.

2. r_{it-1} is cost of capital in the previous period, p is stock prices, cf is free cash flows, e refers to firms' net income and x is real trade-weighted exchange rates. All the variables in lower case indicate their logarithms. All the interaction terms are calculated from the interaction between exchange rates and cost of capital, net income and free cash flows respectively. Furthermore, we allow for financial crises during this sample period. Crisis stands for the current financial crisis, which began in 2008 and is still ongoing. Standard errors are reported in parentheses and are robust to heteroskedasticity and serial correlation. *** denotes significance at a 1% confidence level, ** at a 5% level and * at a 10% level.
3. The instrument variable includes the first-difference values of the dependent variable, cost of equity and earnings dated t-1 and earlier for residual earnings equation, and the first-difference values of the dependent variable, cost of equity and free cash flows dated t-1 and earlier for the Free Cash Fows equation.
4. The values of the Arellano-Bond test for first-order and second-order serial correlation of the differenced residuals are also reported in the table, with the p-values in parentheses. Autocorrelation at order one is expected in the first difference, since $\Delta\mu_{it}$ and $\Delta\mu_{it-1}$ share the μ_{it-1} item. However, for AR (2) in differences, the null hypothesis of no serial correlation should not be rejected if the model is correctly specified.
5. Hansen is a test of over-identifying restrictions asymptotically distributed as a χ^2. For two-step robust GMM estimators, the Sargan statistics is not robust to heteroscedasticity or autocorrelation. However, the Hansen J-statistics is robust to check whether the instruments, as a group, appear exogenous. It is expected to not reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term. One caution for these test statistics is that they can be greatly weakened by the use of so many instruments.

6. The Difference-in-Hansen test is employed for the validity of the subsets of instruments.
7. Chi square-statistics for the equation test the null hypothesis that all the coefficients are jointly zero.

CHAPTER 5

WHERE DOES FOREIGN EXCHANGE RISK COME FROM? STOCK PRICE DYNAMICS AND THE SOURCES OF FOREIGN EXCHANGE EXPOSURE: FIRM-LEVEL ANALYSIS

5.1 Introduction

Financial theory suggests that the value of a firm will be affected by foreign exchange rates. The sensitivity of stock prices with respect to exchange rates is referred to as exchange rate exposure in research. This exposure, usually defined as foreign exchange beta, is central to individual investors and firms. For example, changes in exchange rates will affect the value of portfolios consisting of securities from different countries for investors. (Bredin & Hyde, 2011) The cash flows of multinational firms will be naturally affected, due to, import or export activities as well as various operation locations. Even for domestic companies, changes in exchange rates will have an impact through the competitive environment and imported inputs. (See, for example, Bodnar et al., 2002, Aggarwal & Harper, 2010, Hutson & Stevenson, 2010; among many others) Given its importance, it is natural to ask how foreign exchange beta is determined. Although there is abundant literature on the magnitude of foreign exchange exposure, there is little evidence about its sources. Therefore, this chapter will make attempt to find out where foreign exchange risk comes from.

Campbell and Shiller (1988) and Campbell (1991) demonstrated that unexpected returns can be written approximately as a linear function of innovations of cash flows and excess returns. Based on this, Campbell and Mei (1993) decomposed the market beta into real interest rate beta, future cash flow beta and future excess return beta. In this research, we make an initial attempt to employ this fundamental analysis by the present-value relation to decompose foreign exchange beta for firms.

In this chapter I employ a firm-level first order vector autoregressive (VAR) model and Campbell's return decomposition framework to analyse the firms' foreign exchange risks, based on a large panel of UK-listed non-financial firms for the period 1990-2011. The return decomposition framework enables me to decompose the foreign exchange betas into two components: foreign exchange betas of cash flows, and foreign exchange betas of discounted rates. Therefore, as a contrast to the previous chapters on exchange rate pass-through effect, this chapter employs the definition of foreign exchange beta, which is usually used to measure the risk and determine the return in financial research, as well as Campbell and Shiller's (1998) framework to decompose the foreign exchange betas. More importantly, unlike previous chapters, this study distinguishes the expected and unexpected parts of changes in exchange rates, thus offering a more precise result for the exchange rate exposure issue. In addition, the effect of firms' characteristics including industry and size on foreign exchange risks is also investigated. This original research can shed light on and provide a ground-breaking understanding of firms' foreign exchange risks.

The empirical results presented in this chapter firstly confirm the cash flow and discounted rate transmission channels, through which changes in exchange rate pass-through into stock prices, as seen in the previous two chapters. Moreover, they shows that the significant level of foreign exchange exposure increases dramatically when taking into account this decomposition of foreign exchange betas. More importantly, foreign exchange exposure via the discounted rate channel tends to dominate the effect via the cash flow channel during the period 1990-2011. However, in 1990-2008, foreign exchange effect via the discounted rate channel cannot outweigh the impact via the cash flow channel, which implies that the effect of the discounted rate channel increases dramatically during times of financial crisis.

One of the arguments of this chapter is that unanticipated changes in exchange rate will be employed, instead of actual changes. Although the majority of previous studies on foreign exchange exposure adopt realized changes in exchange rates as the proxy of unexpected changes (See, for example, Choi and Prasad, 1995; Carrieri, Errunza & Majerbi, 2006; Bartram, 2007; Choi & Jiang, 2009; among many others), it is not an appropriate measurement. Finance theory suggests that the expected changes should have little effect on assets and be already priced into assets. (Bredin & Hyde, 2011) As a result, it is helpful to distinguish the anticipated and anticipated parts of changes in foreign exchange rates, in order to employ only the unexpected part when examining currency exposure.

Another key distinction between this and the majority of other research is that we provide new empirical evidence to explain the foreign exchange rate puzzle. The foreign exchange rate puzzle is the name given to a low level of significant exposures found in empirical studies, although finance theory suggests that exposure should exist because of unexpected changes in cash flows. Only 10-25% of firms are found to be significantly exposed to foreign exchange rates in empirical research, no matter what kind of data and model are used. (See, for example, Jorion, 1990; He and Ng, 1998; Bartram, 2007; Bartram & Bodnar, 2007; Chue and Cook, 2008; Aggarwal and Harper, 2010; among many others) There are two ways of explaining the foreign exchange exposure puzzle. On the one hand, research makes an effort to solve it on the basis of shortcomings in estimation methodology for currency exposure. On the other hand, many researchers attribute this significance of exchange rate exposure to corporation hedging activities, such as financial and operational hedging. However, in this study, we employ the Campbell-Shiller approximation of expected returns to examine the components of return exposure, such as future cash flow components and discount rate components (future excess return components). Thus, the complementary effects between future cash flow effects and future excess return effects provide an additional explanation for the foreign exchange rate puzzle.

In addition, this chapter contributes to research by adding new evidence on foreign exchange betas, which are very useful measurements in modern finance. Both academics and practitioners employ betas to model and control non-diversifiable risk, to be determinants for expected returns in the asset pricing model such as the capital asset pricing model (CAPM), intertemporal CAPM, and arbitrage pricing models. (Campbell and Mei, 1993) Thus, investigating the foreign exchange rate exposure in terms of decomposing foreign exchange beta can be easily extended to risk pricing analysis, the time-varying risk model, and other researches, as well as revealing where foreign exchange exposure comes from.

Bredin and Hyde (2011) identify the sources of foreign exchange exposure and suggest cash flow and discount rate exposure as its two components. However, this chapter differs from theirs in several following ways. Firstly, the firm is the unit of analysis, rather than industry. This is because, despite the evidence of exchange exposure on the aggregate level, such as in market or industry portfolios, there is no study to show this effect on a more disaggregated firm level. Finance theory or empirical surveys of foreign exchange exposure are conducted on the basis of individual firms, and thus firm-level analysis is more appropriate for this context. Further, research suggests a strong relationship between currency exposure and firm characteristics such as size, international activities and hedging activities. Therefore, an average effect based on a coarser information set, such as grouping by industry, is misleading. (He & Ng, 1998)

Secondly, while Bredin and Hyde (2011) employed a simple extension of Jorion's (1990) approach to return forecasting, the firm-VAR model which captures all the important empirical return-predictability returns is used in our analysis. Research has suggested fatal problems with CAPM's explanation of expected returns, especially for size and value premium. (See, for example, Fama and French, 2006; Lewellen & Nagel, 2006; among many others) Moreover, there is increasing research arguing for the use of accounting data or fundamental factors rather than CAPM, when calculating costs of capital. (See, for example, Campbell, Polk & Vuolteenaho, 2010;

Morningstar, 2011; among many others) As a result, we consider both value effect and profitability in our firm-level stock returns forecasting approach, which has been demonstrated to be more powerful in predicting expected stock returns. (See, for example, Campbell & Mei, 1993; Vuolteenaho, 2002; Campbell, Polk & Vuolteenaho, 2010; among many others)

Thirdly, this research focuses on annual data, rather than monthly data as was the case with Bredin and Hyde (2011). Chow, Lee and Solt (1997) suggested that long-term exchange rates and asset returns should be employed to investigate the relationship between exchange rates and stock prices, because there are forecasting errors if short-term returns are used to forecast the long-term effects of foreign exchange rate changes. (Chow, Lee and Solt, 1997) This is why the majority of previous studies based on noisy monthly stock returns fail to detect significant exposures, and the percentage of significant exposures rise, as the return horizon increases. (Bartram & Bodnar, 2007)

Therefore, this chapter will contribute to research in many ways. Firstly, it offers more precise results of foreign exchange exposure by distinguishing the anticipated and unanticipated parts of changes in foreign exchange rates. Secondly, the important concept in modern finance of foreign exchange beta is decomposed so that it is easily extended to risk pricing analysis and the time-varying risk model. Finally, this research employs all the important empirical return-predictability returns for stock returns, and provides a new explanation for the foreign exchange puzzle as well.

The reminder of the chapter is organised as follows. Section 5.2 reviews the theoretical framework and the empirical model specification used. The sample and data preliminary analysis are presented in Section 5.3. Section 5.4 describes the empirical results of decomposition of foreign exchange betas. Section 5.5 offers a further robustness check, followed by the concluding remarks in Section 5.6.

5.2 Theoretical Framework

5.2.1 Return decomposition

Our analysis is based on the Campbell and Shiller (1988) dividend-growth model, thus we will briefly review this model and extensions of it in this section. Campbell and Shiller (1998) defined a cumulated dividend equity return as follows:

$$g_t = \log\left(P_{i,t+1} + D_{i,t+1}\right) - \log(P_{i,t}) \tag{5.1}$$

Where $P_{i,t}$ is the ex-dividend stock price at the end of time t, $D_{i,t}$ is the dividends paid during the period of t, and g_t is the one-period log holding return on stock i. In order to obtain the linear valuation, Campbell and Shiller (1998) use a first-order Taylor expansion to approximate this equation as

$$g_t \approx h + \rho p_t + (1-\rho)d_t - p_{t-1} \tag{5.2}$$

Where h is a constant and is defined by $h \equiv -\log(\rho) - (1-\rho)\log(1/\rho - 1)$,ρ is a constant error approximation term of linearization defined as$\rho \equiv 1/(1+\exp(\overline{d_t - p_t}))$. All the lower case letters refer to log forms of variables. Furthermore, Campbell and Shiller imposed the "no-infinite-bubbles" terminal condition that $\lim_{j\to\infty} E_t\, \rho^j p_{i,t+j} = 0$, which can rule out "rational bubbles". By solving equation (5.2) forward for price and taking expectations, one gets

$$p_t = \frac{h}{(1-\rho)} + E_t[\sum_{j=0}^{\infty} \rho^j((1-\rho)d_{t+1+j} - g_{t+1+j})] \tag{5.3}$$

This equation shows that the log current price of equity can be written as a constant plus the sum of expected future dividends, less expected future returns, discounted as a constant rate ρ. In other words, equation (5.3) suggests a higher equity price as a result of increased dividends or lower expected returns.

The unexpected change in current returns can be obtained by substituting equation (5.3) for equation (5.2). (Campbell and Shiller, 1991) As is shown by equation (5.4), unexpected stock returns can be decomposed as in the following equation:

$$\widetilde{e_{i,t+1}} = g_{t+1} - E_t g_{t+1} = (E_{t+1} - E_t)\sum_{j=0}^{\infty} \rho^j\, \Delta d_{t+1+j} - (E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j r_{t+1+j}$$

$$= \widetilde{e_{d\iota,t+1}} - \widetilde{e_{e\iota,t+1}} \quad (5.4)$$

Here, the unexpected stock returns $\widetilde{e_{\iota,t+1}}$ can be simply decomposed into two components: $\widetilde{e_{d\iota,t+1}}$ denotes news or innovations about cash flows, and $\widetilde{e_{e\iota,t+1}}$ is the news or innovations about future discount rates. It shows that the unexpected stock returns can be decomposed into two parts: one from unexpected changes in cash flows, and the other rises from unexpected changes in discount rate. More specifically, increased expected future cash flows are today suggested to cause an increase in unexpected stock returns, while an increase in discounted rate should be associated with a decrease in today's unexpected stock returns.

This return decomposition is important in provide insights on the drivers of stock prices. Therefore, investigating the impact of any factor on these drivers, which thus affects equity price, is a powerful way of offering detailed information about the relationship between this factor and stock prices. In terms of the effect of exchange rate risk on stock prices, it can be thus decomposed into impact on cash flows and on discount rates. Unexpected exchange rates will have an impact on firms' cash flows through the effect on import prices, selling price abroad and import competition. At the same time, the required return on stock will also be increased as the currency risk goes up. By noting return decomposition, we can see how and why exchange rates have an impact on stock prices.

5.2.2 Beta decomposition

As Campbell and Mei (1993) suggest, beta is defined as the covariance of innovations in returns and factors divided by the factor innovation's unconditional variances. It measures an asset's sensitivity with respect to a factor. Therefore, our definition of the foreign exchange beta can be shown as

$$\beta_{i,fx} \equiv Cov(\tilde{e_i}, \widetilde{e_{fx}})/Var(\widetilde{e_{fx}}) \tag{5.5}$$

Here, $\tilde{e_i}$ is unexpected excess returns on asset i and $\widetilde{e_{fx}}$ is unexpected excess returns on the foreign exchange risk factor. This definition has the advantage that beta can be decomposed into components in a relatively simple way (Campbell and Mei, 1993). Further, our foreign exchange beta defined as equation (5.5) can be broken into two beta components:

$$\beta_{di,fx} = Cov(\widetilde{e_{di}}, \widetilde{e_{fx}})/Var(\widetilde{e_{fx}}) \tag{5.6}$$

and

$$\beta_{ei,fx} = Cov(\widetilde{e_{ei}}, \widetilde{e_{fx}})/Var(\widetilde{e_{fx}}) \tag{5.7}$$

$\beta_{di,fx}$ and $\beta_{ei,fx}$ are respectively the cash flow component beta and discounted rate component beta, with respect to foreign exchange rate. Equation (5.4) allows these two components to add up to our foreign exchange beta, as shown in equation (5.8).

$$\beta_{i,fx} = \beta_{di,fx} - \beta_{ei,fx} \quad (5.8)$$

This two-way decomposition of foreign exchange beta allows us to find out whether foreign exchange rate exposure is attributed to their cash flows or to discount rates.

5.2.3 Empirical model for beta components

In order to make the decomposition feasible, this section constructs empirical models to obtain the proxies for unexpected returns on cash flows (CF news) and discounted rates (DR news) respectively. As Sims (1980) and others suggested, in a series of influential early papers, VARs, as a coherent and credible approach, should be applied for data description, forecasting and other analysis. (Sims, 1980) Thus, we use a first-order VAR model here to estimate these two components.

$$z_{t+1} = \alpha + \Gamma z_t + u_{t+1} \quad (5.9)$$

Where z_{t+1} is an m-by-1 state vector with g_{t+1} as its first element, α is a m-by-1 vector defined as constants and Γ are m-by-m matrix of parameters, and u_{t+1} is an i.i.d. m-by-1 innovation. Equation (9) allows us to estimate the effect of today’s shocks on the discounted future.

In our analysis, we specify the state variable as follows: log firm-level return, log book-to-market ratio, log long-term profitability (ROE), and log foreign exchange rates, as suggested by Campbell, Polk and Vuolteenaho (2010). Firstly, the log book-to-market ratio is included in order to capture the well-known value effect in cross-section stock returns. (See, for example, Fama and French, 1992; Fama and Frence, 2006; among many others) Next, long-term profitability in log form is included to capture the evidence that firms with higher profitability earn a higher return on average. (Haugen and Baker, 1996) The foreign exchange rate is added as our last element in the VAR model, as stock prices can be explained much more easily by adding foreign exchange rates as additional variables. (Chow, Lee and Solt, 1997) Provided the above VAR generates the data, the unexpected effects on cash flows and discount rates are suggested to be linear functions of the t+1 shock vector:

$$\widetilde{e_{e\iota}} = \mathrm{e1}'\lambda \mathrm{u}_{\mathrm{t+1}}; \tag{5.10}$$

$$\widetilde{e_{d\iota}} = (\mathrm{e1}' + \mathrm{e1}'\lambda)\mathrm{u}_{\mathrm{t+1}}; \tag{5.11}$$

Where, $\widetilde{e_{e\iota}}$ is the discount rate news (DR news); and $\widetilde{e_{d\iota}}$ is the cash flow news, (CF news), e1 is a vector with the first element equal to unity and the remaining elements are zero. The VAR shocks can then be mapped to cash flow related effects and discount rates related effects by λ, defined as$\lambda \equiv \rho\Gamma(\mathrm{I} - \rho\Gamma)^{-1}$. (Campbell, Polk and Vuolteenaho, 2010) Γ is the VAR parameter estimate matrix, I is an identity matrix, and ρ is a linear parameter and is set at 0.95 followed literature here[10]. A greater value of a factor's coefficient in the return prediction equation will lead to a greater effect through the discounted rate channel.

[10] Results are robust to reasonable variation in ρ.

5.3 Data and preliminary analysis

5.3.1 Sample and data requirements

This chapter examines the degree of foreign exchange rate exposure in all non-financial firms in the UK[11], from 1990 to 2011[12]. The initial sample contains all non-financial firms listed in London Stock Exchange (LSE), including both active and inactive ones. The basic data is collected from three different sources. The trade-weighted exchange rate comes from the official site of the Bank of England; the relevant accounting information is from the Worldscope database via Thomas one banker analytics; and the three-month Treasury bill rate, market index rate for non-financial firms in the UK and monthly stock prices come from DataStream[13]. All variables are of annual frequency.

The sample is restricted by the following requirements. Firstly, a firm must have t-1, t-2, and t-3 book equity, where t refers to time in years. Secondly, there also needs to

[11] Financial companies are different from the other firms in terms of risk management and other financial activities, and thus we excluded these firms from our analysis, as research has recommended.

[12] Our main variable trade-weighted exchange rate is only available from 1990, and thus we studied this relationship between 1990 and 2011.

[13] Since there are no monthly stock prices available from the Worldscope database, this data is retrieved from Datastream for the same firms over the same period.

be information on t-1, t-2 net income and total debt data. Thirdly, firms without valid market equity figures are also excluded from the sample. Furthermore, since all the variables in the regression are in log form, all negative figures are omitted from the sample. In addition, I truncated all the data outliers to their 1% and 99% percentile value, in order to screen out extreme figures. Thus the final sample includes 780 non-financial firms, and7129 firm-year observations.

5.3.2 Variables definitions and transformations

The definition of each variable is summarized in Table 5.1. As it shows, there are four state variables used in the main specification of our empirical VAR models. Firstly, the log firm-level return (g_i) is an annual simple return on firms' common stocks, which are compounded from monthly returns during that year. If there is no return data available, I substitute zero for the return. In addition, following Vuolteenaho (2002) and Campbell, Polk & Vuolteenaho (2010), the stock return is unlevered by 10%, since log transformation can turn extreme values into influential observations in regression. It means that the stock return is actually the return of a portfolio, consisting of 90% of a firm's common stocks and 10% in Treasury bills.

Secondly, log book-to-market ratio is included in order to capture the well-known value effect in the cross-sectional stock returns. The market value at time t is defined as stock prices times all common shares outstanding at time t. For book equity, I use the book value from the financial report, which is the difference between total assets and total liabilities. The negative or zero book equity values are treated as missing here. As a result, the log book-to-market ratio is defined as book equity values at time t-1 divided by market equity values at time t. Similarly to log firm-level return, log book-to-market ratio is specifically defined as BM=log[(0.9Book equity+0.1market equity)/market equity], in order to deal with the problems when using log transformation. (Campbell, Polk & Vuolteenaho, 2010)

Table 5.1: Definitions of state variables used in Chapter 5

Variables	Definition	Sources
Firm-level return (g_i)	Annual simple return on firms' common stocks, compounded from monthly returns.	Datastream database
Book-to-market (BM)	Book equity values at time t-1 divided by market equity values at time t.	Worldscope database via Thomas one banker analytics
Return on equity (ROE)	Earnings over the last period's book equity.	Worldscope database via Thomas one banker analytics
Foreign exchange return (r_{fx})	Annual simple return on trade-weighted exchange rate (nominal and real) of sterling from the Bank of England.	Bank of England

Notes:

1. All the data are collected from the Worldscope database via Thomas one banker analytics, except monthly stock prices.
2. Monthly stock prices are retrieved from the Datastream database for the same period.

The third state variable included in our VAR specification is firms' profitability, measured by return on equity, as research has suggested that stock return should increase as a result of higher profitability. The return on equity (ROE) is defined as earnings over the last period's book equity. For earnings, we use the net income before the extraordinary items in the financial report. Book equity is also unlevered by 10%, like the previous two variables.

In addition, foreign exchange rates enter into our firm-level VAR as the fourth state variable. Although the above three variables are workable for an explanation of the cross-sectional average returns in research, Chow, Lee and Solt (1997) suggested that stock returns can be explained by more than 200%--300% by adding foreign exchange rate into stock return models, for a forecast horizon greater than six months. Both the nominal and real trade-weighted exchange rate indexes (January 2005=100) are employed in this research. The trade-weighted exchange rate is calculated as a weighted average of several bilateral exchange rates, defined as the value of sterling against foreign currency, for the Euro, US dollar, Chinese renminbi, Japanese yen and Indian rupee. The weights are related to recent trade patterns, and calculated by the

Bank of England. (Bank of England, 2004) An increase in trade-weighted exchange rate indicates an appreciation of sterling.

Finally, the year-specific means of log book-to-market ratio and log return on equity are removed by subtracting their cross-sectional means. For log firm-level return, we subtract the log value of market index for non-financial firms from the log firm stock return, to get the market-adjusted return. (Campbell, Polk & Vuolteenaho, 2010) After demeaning the firm specific variables, the coefficient of the firm-level VAR model can then be estimated by the weighted least square method (WLS), equation by equation. Following Campbell, etc (2010), the number of cross-sectional observations that year is employed as weights to weight each cross-section equally. Therefore, our estimates will not be dominated by any large cross-sections from a specific year.

5.3.3 Descriptive statistics

Table 5.2: Descriptive statistics

Variable	Mean	St. Dev.	Min	25%-pct	Median	75%-pct	Max
Panel A: Descriptive Statistics, Basic Data							
g_i	0.0444	0.4265	-2.2057	-0.1517	0.0574	0.2627	3.3201
ROE_i	-2.3283	1.5036	-24.0363	-2.6337	-2.0194	-1.5987	2.2113
BM_i	-0.6687	0.9638	-2.3026	-1.3085	-0.7816	-0.1521	5.0955
r_{fx1}	-0.0092	0.0651	-0.1521	-0.0373	-0.0016	0.0294	0.1574
r_{fx2}	-0.0127	0.0628	-0.1545	-0.0346	-0.0044	0.0196	0.1549
Panel B: Descriptive statistics, variables winsorised at the top and bottom 1st percentile and demeaned							
$\tilde{g_\iota}$	-0.0018	0.3963	-1.4201	-0.2048	0.0018	0.2149	1.1761
$\widetilde{ROE_\iota}$	0.0328	1.2328	-6.4262	-0.3121	0.2991	0.7196	1.9262
$\widetilde{BM_\iota}$	0.0395	0.9186	-1.7455	-0.5833	-0.0651	0.5495	2.9589

Notes:

1. Panel A reports the means, standard deviations, minimum, 25% percentile, median, 75% percentile and maximum values of the four state variables including log firm-level return, g_i, log form of return on equity, ROE_i, log book-to-market ratio, BM_i, log return on nominal trade-weighted exchange rate, r_{fx1}, and log return on real trade-weighted exchange rate, r_{fx2}.
2. Panel B shows all the statistics for winsorised and demeaned data. Winsorisation is employed in STATA to deal with the extreme values in the statistical data. Specifically, we set all the data above 99% at the 99% values, and data below 1% as equal to 1% value, while all other data stays unchanged. Demeaning refers to subtracting return on the non-financial index from log

firm-level return, $\widetilde{g_1}$, and cross-sectional means from log book-to-market ratio, $\widetilde{BM_1}$, and log return on equity each year, $\widetilde{ROE_1}$.

3. The descriptive statistics are estimated from the pooled 1990-2011 UK firm data, consisting of 7129 firm-year observations.

Table 5.2 presents the descriptive statistics for the state variables used in our firm-level VAR model. Panel A reports the means, standard deviations, minimum, 25% percentile, median, 75% percentile and maximum values of the four state variables including log firm-level return, g_i, log form of return on equity, ROE_i, log book-to-market ratio, BM_i, log return on nominal trade-weighted exchange rate, r_{fx1}, and log return on real trade-weighted exchange rate, r_{fx2}. Panel B shows the same statistics for firm-specific data including log firm-level return, $\widetilde{g_1}$, log form of return on equity, $\widetilde{ROE_1}$ and log book-to-market ratio, $\widetilde{BM_1}$, after winsorisation and demeaning. All the statistics are estimated from pooled data for the period 1990-2011.

It can be seen that there is no significant difference between nominal trade-weighted exchange rates and real ones. The returns on nominal trade-weighted exchange rates are a little higher and more volatile than the returns on real ones. In terms of firm specific variables, Panel A of Table 2 shows that all are skewed. While log firm-level return and log return on equity are skewed to the left (negatively skewed), as indicated by higher values of their medians compared to their means, the log book-to-market ratio is skewed to the right (positively skewed), as indicated by a lower value of its median compared to its average. Furthermore, return on equity is the most volatile variable, compared to book-to-market and firm return variables. Panel B of Table 2 shows that winsorisation and demeaning reduce the standard deviation of all the firm specific variables considerably. Therefore, our results are all based on the variables after winsorisation and demeaning.

The pair-wise correlations among the state variables are presented in Table 5.3. A notable feature of the correlation matrix is that the four state variables (namely $\widetilde{g_\iota}$, $\widetilde{ROE_\iota}$, $\widetilde{BM_\iota}$, and r_{fx1} or r_{fx2}) and their one-year lag values are significantly correlated with one another except for the correlation between return on foreign exchange rate and return on equity (ROE). Furthermore, while all the current correlation coefficients are positive, log firm-level return is negative related to log book-to-market ratio. For the one-year lag values, the majority of the variables are positively related to each other. Since firm-level stock returns are very significantly related to the other state variables used in firm-level VAR, including log return on equity, log book-to-market ratio, and return on (nominal or real) foreign exchange rates, it is demonstrated that our VAR model is well equipped to explain the dynamics of stock prices. Whether we employ nominal or real trade-weighted exchange rates, it does not greatly alter our results, since the correlation coefficient of nominal and real trade-weighted exchange rates is almost 1 (0.99). Thus, our analysis is mainly based on real trade-weighted exchange rates. In addition, there is no evidence of multicollinearity shown in the correlation coefficient matrix.

Table 5.3: Correlation coefficient matrix of state variables

	$\tilde{g_\iota}$	$\widetilde{ROE_\iota}$	$\widetilde{BM_\iota}$	r_{fx1}	r_{fx2}	$\widetilde{g_{t-1}}$	$\widetilde{ROE_{t-1}}$	$\widetilde{BM_{t-1}}$	$r_{fx1,t-1}$	$r_{fx2,\ t-1}$
$\tilde{g_\iota}$	1									
$\widetilde{ROE_\iota}$	0.09 ***	1								
$\widetilde{BM_\iota}$	-0.05 ***	0.03 *	1							
r_{fx1}	0.05 ***	0.00	0.05 ***	1						
r_{fx2}	0.05 ***	0.00	0.05 ***	0.99 ***	1					
$\widetilde{g_{\iota-1}}$	-0.00	0.10 ***	-0.06 ***	0.10 ***	0.11 ***	1				
$\widetilde{ROE_{t-}}$	0.05 ***	0.70 ***	0.05 ***	-0.02	-0.02	0.09 ***	1			
$\widetilde{BM_{t-1}}$	0.04 **	0.06 ***	0.89 ***	0.03 *	0.03 *	-0.07 ***	0.02	1		
$r_{fx1,t-1}$	-0.13 ***	0.01	0.04 ***	0.17 ***	0.14 ***	0.04 ***	-0.00	0.03 *	1	
$r_{fx2,t-1}$	-0.14 ***	0.01	0.04 ***	0.17 ***	0.13 ***	0.05 ***	-0.00	0.03 *	0.99 ***	1

Notes:

1. The results are based on a sample period between 1990 and 2011.
2. The values in each cell are the pair-wise Pearson correlations between the corresponding winsorised and demeaned variables.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

5.4 Empirical results

5.4.1 Decomposition of stock returns

The first-order VAR coefficient estimates are shown in Table 5.4. The firm-level VAR model includes log firm-level stock return, log book-to-market ratio, log return on equity and log return on real trade-weighted exchange rates as the state variables, and the parameters are estimated using the weighted least square estimator, with one pooled equation per state variable. Each row in Table 4 reflects a regression result for a corresponding equation. It can be seen that while the R^2 is only 2.6% and 1.2% for the log firm-level stock return equation and the log foreign exchange rate return equation, it increases to 83.9% and 49.5% for the log book-to-market equation and log profitability equations respectively. However, for all these equations, the forecasting variables are all at a significant at 1% level.

The first row in Table 5.4 summarises the parameter estimates for log firm-level stock returns. It implies that the firm's stock return will be high when the past book-to-market ratio and the firm's profitability are high and the return on foreign exchange rates is low. But the lagged stock return individually is not significant when forecasting stock returns. The remaining rows of Table 4 present the dynamics of the explanatory variables. Book-to-market ratio and firms' profitability follow a persistent process, especially in the case of book-to-market ratio since it is approximately an AR (1) process with an autoregressive coefficient equal to 0.9. Furthermore, book-to-market ratio and firms' profitability are found to be significantly affected by their lagged value and lagged stock returns, while there is no significant evidence for the impact of foreign exchange rates on them. However, all the state variables are shown to affect return on currency. It will be high when there is high past stock return, high past book-to-market ratio, high past currency return and low past profitability. Although there is some evidence of instability in the VAR system, all the empirical results (including R^2, parameter estimates, t-statistics, etc.) obtained here are found to be consistent with research, such as Campbell, 1991; Campbell & Vuolteenaho, 2004 and Campbell, Polk & Vuolteenaho, 2010. Finally, we are much more interested in the unexpected parts generated by the VAR model than the parameter estimates, although it is usually difficult to interpret the coefficients obtained from VAR estimations.

Table 5.5 presents the variance-covariance matrix of two components of unexpected stock returns. The total variance of the unexpected stock returns equals the sum of variance of cash flow news (0.1481), variance of discounted rates news (0.0053) and twice the covariance of this two (0.0037), which makes the total variance of the return 0.1608. Therefore, it suggested that cash flow news should be the main driver of firm-level stock returns, since it accounts for 92% (0.1481/0.1608) of the total variance. Discount rates news only accounts for 3% of the total variance, while the remaining amount is due to the covariance between these two components. The result is consistent with the findings of Campbell (1991), Campbell & Vuolteenaho (2004), and Campbell, Polk & Vuolteenaho (2010).

Table 5.4: Firm-level VAR parameter estimates

	$\widetilde{g_{\iota,t-1}}$	$\widetilde{BM_{\iota,t-1}}$	$\widetilde{ROE_{\iota,t-1}}$	$r_{fx2,t-1}$	R^2	Joint sig.
$\widetilde{g_{\iota,t}}$	0.0261	0.0165***	0.0129**	-0.880***	0.0264	36.85***
	(0.0174)	(0.00548)	(0.00533)	(0.0768)		
$\widetilde{BM_{\iota,t}}$	-0.0614***	0.901***	0.0236***	0.0352	0.839	6068.8***
	(0.0150)	(0.00588)	(0.00419)	(0.0830)		
$\widetilde{ROE_{\iota,t}}$	0.115***	0.0413***	0.688***	-0.0742	0.495	298.2***
	(0.0304)	(0.0115)	(0.0205)	(0.151)		
$r_{fx2,t}$	0.0124***	0.00274**	-0.00214**	0.0681***	0.0117	18.99***
	(0.00217)	(0.00108)	(0.000914)	(0.0124)		

Notes:

1. This table shows parameter estimates for the first-order firm-level VAR model using the weighted least square (WLS) estimator. The state variables included in this VAR specification are log firm-level stock return ($\tilde{r_i}$), log book-to-market ratio ($\widetilde{BM_i}$), log return on equity ($\widetilde{ROE_i}$) and log return on real trade-weighted exchange rate (r_{fx2}). The three firm specific variables are winsorised to deal with extreme values, and demeaned by subtracting their cross-sectional means from log book-to-market ratio ($\widetilde{BM_i}$), log return on equity ($\widetilde{ROE_i}$), and subtracting the return on market index for non-financial firms from log firm-level stock return ($\tilde{r_i}$).
2. The VAR is estimated using the weighted least square estimator for a large group of UK-listed non-financial firms during the period 1990-2011, with 7129 firm-year observations.
3. Rows correspond to dependent variables, and the independent (lagged dependent) ones are tabled in columns. The point coefficient estimates are shown in the first four columns, and Heteroskedasticity-corrected standard deviations are presented in parentheses. The fifth column reports the corresponding R^2 for each equation in our VAR specification. The last column presents the F-statistics for the joint significance levels of the VAR forecast variables.
4. * significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level

Table 5.5: Variance-covariance matrix of CF and DR news

	$\widetilde{e_{e\iota}}$	$\widetilde{e_{d\iota}}$
$\widetilde{e_{e\iota}}$	0.0053	
$\widetilde{e_{d\iota}}$	0.0037	0.1481

Notes:

1. This table shows the variance-covariance matrix of the two components of unexpected firm-level returns, discounted rate news ($\widetilde{e_{e\iota}}$) and cash flow news ($\widetilde{e_{d\iota}}$), using the four state variable VAR model from Table 5.4. The VAR model includes log firm-level stock return, log book-to-market ratio, log return on equity and log return on real trade-weighted foreign exchange rate. The two components are calculated by equations (5.10) and (5.11) in Section 5.2.3.
2. The sample period for the dependent variable is 1990-2011, resulting in 780 UK firms consisting 7129 firm-year observations.

5.4.2 Decomposition of foreign exchange betas

Based on the unexpected components of stock returns obtained above, this section decomposes foreign exchange rate risks. Tables 5.6 and 5.7 clarify the sources of foreign exchange risks by decomposing foreign exchange betas into cash flow components and discounted rates components. It is only by decomposing the foreign exchange rate betas that we clearly understand firms' foreign exchange exposures. The foreign exchange betas here are obtained from the definition of betas in equations (5.5), (5.6) and (5.7). Thus, foreign exchange beta (cash flows/discounted rates beta) is the unconditional covariance of stock return (cash flows/discounted rates components) innovation with foreign exchange innovation, divided by the unconditional variance of foreign exchange news. The first column shows total foreign exchange exposures, and the second and third give the decompositions including foreign exchange betas with cash flow news ($\beta_{di,fx}$) and discounted rate news ($\beta_{ei,fx}$) respectively.

5.4.2.1 A decomposition of firms' foreign exchange betas according to industry

Table 5.6 reports the decomposition of firms' foreign exchange betas as a function of industry. There are several features worth noting here. Firstly, UK firms on average are positively exposed to foreign exchange rate risks. When there is one percent unanticipated increase in real trade-weighted exchange rates for sterling, the unexpected return for UK firms will increase by approximately 0.37 percent on average. This impact for the aggregate stock market is due more to changing expected discounted rates than to revisions in expectations about future cash flows, since the absolute value of discounted rates betas is higher than the cash flow betas. This implies that the transitory effects of discounted rates ("good" beta) outweigh the permanent effects of cash flows ("bad" beta)[14]. In other words, foreign exchange

[14] Campbell and Vuolteenaho (2004) defined the cash flow beta as "bad" beta since the returns generated by this news will never be reversed. On the other hand, the discounted rate beta is defined

exposure via the discounted rate channel tends to dominate the effect via the cash flow channel, and this channel helps firms to bear the brunt of currency exposure, by offering positive investment opportunities in the future on average. This result is consistent with research. For example, Bredin and Hyde (2011) found higher excess return betas than cash flow betas for the US and the UK, although the evidence for the UK is not significant (Bredin and Hyde, 2011). This result indicates the reason why previous research fails to uncover significant foreign exchange exposure. However, it is somewhat as odds with the results documented in previous chapters. In Chapters 3 and 4, we found that the permanent bad effects outweigh the transitory good effects. This divergence in the findings is attributed to the difference between actual and unexpected changes in exchange rates. In other words, the effect of unexpected exchange rate fluctuations on stock prices via the discount rates channel outweighs the impact via the cash flow channel, although the transmission channel of actual changes in exchange rate is mostly the revenue-side channel.

Secondly, the level of significant foreign exchange rate exposures increases dramatically once we decompose the foreign exchange betas into cash flow and discounted rate components, suggesting the importance of the channel through which the changes in foreign exchange rates affect stock prices. As can be seen from Table 5.6, almost every industry experiences a significant currency exposure through either

as "good" beta since future lower returns will offset the returns generated by discounted rate news now. (Campbell & Vuolteenaho, 2004) the cash flow channel the discounted rate channel, with the exception of public administration which has a limited number of firms for estimation. However, for total foreign exchange exposure, only four out of nine industries are significantly exposed to foreign exchange risks: the four are the construction industry; transportation, communications electric, gas, and sanitary services industry; retail trade industry and services industry. For example, although the sensitivities of cash flow news and discounted rate news are significant for the manufacturing industry, there is no significant evidence to show the effect of foreign exchange rates on stock prices. Even for industries such as retail, transportation, communications, electric, gas and sanitary Services, whose stock prices are significantly affected by foreign exchange rates, the level of foreign exchange exposure becomes less dramatic once the channels are not taken into account. This is mainly because the discounted rate channel can offset the influences of foreign exchange rates on stock prices through the cash flow channel to some extent, thus making the final total foreign exchange exposure less significant.

Thirdly, there are some notable patterns across industries. One feature worth noting is that stable industries such as services industry, retail trade industry, and transportation, communications, electric, gas, and sanitary services have relatively lower cash flow betas. On the other hand, for cyclical industries such as mining, manufacturing, finance, insurance, and real estate, cash flows are much more sensitive to the business cycle, and thus they have higher cash flow betas. This pattern is not a simple replication of the pattern of total foreign exchange exposure. For example, although services industry has low cash flow betas, its overall foreign exchange betas are among the highest of all industries, due to the effect through the discounted rate channel. Another interesting point is that for some industries such as mining, manufacturing and the wholesale trade, both the cash flow and discounted rate channels are almost equally important, therefore leaving the total foreign exchange exposure very small. If we take manufacturing, for example, an expected 1 % increase in annual real trade-weighted exchange rate for sterling is associated with an only 0.0011% (-0.8308% + 0.8318%) increase in firms' equity returns. These findings potentially explain why previous studies have found a low level of significant foreign exchange exposure in UK firms.

Table 5.6: Decomposition of foreign exchange beta

Industry	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
Agriculture, Forestry and Fishing	-0.3787	-1.1224**	-0.7437***	87
	(0.5503)	(0.5501)	(0.1404)	
Mining	-0.0964	-0.9519**	-0.8555***	187
	(0.4597)	(0.4642)	(0.0780)	
Construction	1.2610**	0.3557	-0.9053***	248
	(0.4130)	(0.4139)	(0.0501)	
Manufacturing	0.0011	-0.8308***	-0.8318***	2286
	(0.1094)	(0.1102)	(0.0145)	
Transportation, Communications, Electric, Gas and Sanitary Services	0.4193*	-0.4162*	-0.8355***	495
	(0.2236)	(0.2230)	(0.0274)	
Wholesale Trade	-0.0636	-0.8668**	-0.8032***	318
	(0.3443)	(0.3511)	(0.0339)	
Retail Trade	0.3951*	-0.4782**	-0.8732***	609
	(0.2290)	(0.2315)	(0.0320)	
Finance, Insurance and Real Estate	-0.3231	-1.2457***	-0.9227***	121
	(0.3947)	(0.4015)	(0.0687)	
Services	1.2826***	0.4271**	-0.8555***	1184
	(0.2033)	(0.2041)	(0.0247)	
Public Administration	-7.4714	-5.5952	1.8762	3
	(12.1264)	(11.1091)	(1.0173)	
Industry average	0.3698***	-0.4735***	-0.8432***	5538
	(0.0783)	(0.0787)	(0.0102)	

Notes:

1. This table shows the decomposition of the real foreign exchange betas of ten industries in the UK. $\beta_{i,fx}$ is total stock return sensitivity to foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to foreign exchange rates, $\beta_{ei,fx}$ is sensitivity of discounted rate news to foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the real foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7) respectively.
2. N refers to the number of observations in each industry. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2011, with 5538 firm-year observations for 663 companies in the UK.
3. * significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level

5.4.2.2 A decomposition of firms' foreign exchange betas according to firms' size

Table 5.7 shows the decomposition of foreign exchange rate betas for different size firms. The first column shows total foreign exchange exposures across firms' size, and the second and the third columns present the cash flow and discounted rate betas respectively. Size 1 contains the smallest firms and size 6 contains the largest. The first column suggests that total foreign exchange rate exposure declines monotonically with firms' size. Furthermore, all firms in the UK are found to be positively related to foreign exchange rates, although this result is not significant for the group of the largest firms (size 6). This implies that in the UK stock returns will be increased as a result of real sterling appreciation. This result is consistent with that from industry in the previous section.

The second and third columns clearly show why UK firms experience such a pattern. Firstly, cash flows are less significantly exposed to foreign exchange risk for small stocks than for large big ones. In addition, the absolute values of betas for discounted rates decline almost monotonically with size. Therefore, the cash flow channel plays an increasingly more important role than the discount rate channel with regard to the effect of unexpected changes in exchange rates on stock prices, as the companies' size increases. However, for all firms, it can be seen that the discounted rates channel dominates the cash flow effect, and this channel bears the brunt of the exposure by offsetting the negative effect on wealth, and offering positive investment opportunities for the future. This confirms the results of the previous section on industries, and those from Bredin & Hyde (2011). Furthermore, this impact is much more influential for small stocks. On the one hand, when the exchange rates of sterling increase, the cash flows for smaller firms decrease less due to their low level of international trade compared to bigger companies, as indicated by the lower cash flow betas for smaller stocks. On the other hand, the discount rate channel offers higher positive investment opportunities for smaller firms, as indicated by a higher coefficient of smaller companies associated with discount rates. Thus, the increased good transit effect and decreased bad permanent effect, as firms' size decreases, make total foreign exchange exposure negatively related to firm size. This result is consistent with research on hedging, such as Dominguez & Tesar (2006), Chue and Cook (2008), Aggarwal and Harper (2010), Hutson and O'Driscoll (2010), Huffman, Makar and Beyer (2010), Hutson and Stevenson (2010). It is suggested that there tend to be more sophisticated hedging techniques for large firms, thus reducing their foreign exchange exposure. However, it is again emphasized that using unanticipated parts of exchange rates for rate exposure makes a big difference, compared to employing the actual changes, as we did in previous chapters.

Table 5.7: Decomposition of foreign exchange beta as a function of size

Size	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
1	0.5039*	-0.3698	-0.8737***	551
	(0.2699)	(0.2702)	(0.0332)	
2	0.3976*	-0.4651**	-0.8627***	834
	(0.2164)	(0.2145)	(0.0238)	
3	0.3525**	-0.4956***	-0.8481***	1384
	(0.1687)	(0.1693)	(0.0188)	
4	0.3488**	-0.4922***	-0.8410***	1385
	(0.1496)	(0.1522)	(0.0230)	
5	0.3445**	-0.4649***	-0.8094***	832
	(0.1736)	(0.1754)	(0.0249)	
6	0.3243	-0.4974**	-0.8217***	552
	(0.2006)	(0.2010)	(0.0302)	

Notes:

1. This table shows decomposition of real foreign exchange betas as a function of firms' size. Size is defined as log form of the total assets. Size 1 refers to the smallest firms, whose total assets are below the 10^{th} percentile of total assets; size 6 contains large firms whose total assets are beyond the 90^{th} percentile of total assets. The remaining size portfolios are firms whose total assets are between the 10^{th} and 25^{th} percentile, 25^{th} and 50^{th} percentile, 50^{th} and 75^{th} percentile and 75^{th} and 90^{th} percentile for sizes 2, 3, 4, 5, respectively. $\beta_{i,fx}$ is total stock return sensitivity to foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to foreign exchange rates, $\beta_{ei,fx}$ is sensitivity of discounted rate news to foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the

real foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7).

2. N refers to the number of observations in each industry. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2011, with 5538 firm-year observations for 663 companies in the UK.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

5.5 Robustness check

5.5.1 Diagnostic checks

The results obtained are striking, and this section will go further and check the robustness of the findings. Firstly, since our main results are obtained using the weighted least square estimator, the assumptions from the least square estimation need to be checked, otherwise our results will be misleading and not verified. Appendix 5.A tables the diagnostic checks for all the decomposition models. Firstly, we conduct unit root tests for each variable used in the regression including excess stock returns, return on equity, book-to-market ratio, real trade-weighted exchange rates for sterling and nominal trade-weighted exchange rates for sterling. Since our data is unbalanced panel data, fisher-type unit-root tests are employed here.[15] The

[15] Other unit root tests can only be used for balanced panel data, such as the Levin-Lin-chu test, the IM-Pasaran-Shin (IPS) test, and Breitung's test, KPSS test, etc.

fisher-type unit test uses the P-values of augmented Dicker-Fuller tests for each cross-section, and this test suggests that all the variables used in this paper are stationary. Therefore, there is no need for other transformations. The second row presents the homoscedasticity tests for each equation in the VAR system. Specifically, the Breusch-Pagan or Cook-Weisberg test is employed for our unbalanced panel regressions. The null hypothesis for all the equations is rejected, suggesting heteroskedasticity problems for the variance. Thus, all the standard errors are heteroskedasticity-corrected in the main results. In addition, variance inflation factors (VIF) methodology is used to test for multicollinearity. All the mean VIF are around 1, and this suggests that there is no significant correlation among predicted variables in the model. Finally, we conduct two model specification tests, the linktest and the Ramsey RESET test. Both tests suggest that the models are all correctly specified and there are no omitted variables.

5.5.2 Alternative VAR systems

Chen and Zhao (2009) pointed that although return decomposition works perfectly in the theoretical framework, the model misspecification becomes a vital issue when it comes to empirical analysis. It is proved that minor changes in model specification can lead to the opposite conclusion for residual-based decomposition; therefore they suggested modelling cash flow news directly, instead. In this section, we follow Chen and Zhao's approach and directly model the cash flow news to check the robustness of our result. Specifically, two separate VAR systems are employed to directly model cash flow news and discount rate news in this robustness check. For discount rate news, we employ the same firm-level first order VAR as in the main result, and the discounted rate news can be obtained from equation (5.10). However cash flow news will be obtained from the following equation.

$$\widetilde{e_{dt}} = el'\lambda_2\omega_{t+1} \tag{5.12}$$

Here, $\lambda_2 = (I - \rho\Gamma)^{-1}$, Γ is the parameter estimate matrix, I is an identity matrix, and ρ is a linear parameter and is set to 0.95 as above. $\widetilde{e_{dt}}$ is direct cash flow news, el' is a vector with the first element equal to unity and the remaining elements zero, and ω_{t+1} is the error term for the new VAR system. The state variables in this direct cash flow measures are return on equity, excess equity return, book-to-market ratio and foreign exchange rates. (Chen and Zhao, 2009)

Appendix 5.B shows the results based on this alternative VAR estimate. Firstly, it can be seen from Appendix B1 that return on equity is significantly affected by last year's ROE, excess return and book-to-market ratio. Secondly, the variance-covariance matrix shows that the cash flow news is also the main driver of total variance, since it accounts for around 91.5% of the total variance (0.7754/0.8471). Thirdly, Appendix 5.B3 and 5.B4 confirm that the level of significance is greatly increased when taking the cash flow and discounted rate channels into consideration. In addition, although there is less evidence of cash flow news due to the insignificant impact of foreign exchange rates on ROE in the VAR estimation, it also confirms that the transitory effect of discounted rates (“good” beta) on average outweigh the permanent effects of cash flows (“bad” beta). In conclusion, all the results here support our main findings in the empirical section.

5.5.3 Estimating the VAR over subsample

Another important issue is the recent financial crisis. Research suggests that variance and covariance between stock prices and foreign exchange rates should increase during a financial crisis. Therefore this section investigates whether contradictory result can be found when excluding the financial periods in the sample. (Appendix 5.C) Firstly, there is no significant difference for the VAR estimates, although last year’s ROE and book-to-market ratio becomes insignificant in the foreign exchange rate prediction equation. Secondly, in terms of the variance-covariance matrix, there is little change in the variances of these two components. However, the covariance between cash flow discounted rate news approximately doubles in this subsample. This does not change the conclusion that variance of cash flow news is the main driver of total variance. While cash flow news accounts for 86.3% (0.1360/0.1575) of the total variance, discounted rate news only accounts for 3.6% (0.0057/0.1575).

Thirdly, Appendices 5.C3 and 5.C4 again show a dramatic increase in foreign exchange exposure when decomposing it into cash flow and discounted rate components. However, it is found that, in this subsample, foreign exchange betas based on the permanent effect of cash flows outweigh the betas based on the transitory effect of discounted rates. This implies that although the discount rate channel can to some extent bear the brunt of currency exposure, the effect through the cash flow channel outweighs it. This divergence can be explained by the increased effect of the discount rates channel during the financial crisis. In this crisis time, the market realized that the banks were insolvent and then banks' liquidity dried up. Furthermore, investors lost confident and high prices for assets prone to sharp drops in liquidity are required. The financial crisis finally becomes economic crisis to the world. Therefore, the required return increased considerably due to illiquidity during financial crisis, which is consistent with our results. Generally speaking, the effect of the discounted rate channel increases significantly during financial crisis, and even makes the discount rate beta greater than the cash flow beta, when including the financial crisis in the entire sample. However, when the financial crisis is excluded in the sample period, the results are consistent with the findings in previous chapters when financial crisis is controlled by a dummy variable.

5.5.4 Real foreign exchange rates vs. nominal foreign exchange rates

Variation in real foreign exchange rates does not necessary imply variation in nominal exchange rates, due to the effect of inflation. For example, the real trade-weighted exchange rate in 1992 was 98.81 while the nominal trade-weighted exchange rate was 90.03. This section employs nominal foreign exchange rates rather than real exchange rates when examining the robustness of my earlier results. Appendix 5.D presents these results. It can be seen that the estimates are nearly unaltered, and there is only 0.001-0.002 difference in the variance-covariance matrix.

Overall, the results obtained are robust with respect to the alternative VAR estimates, different foreign exchange measurements and different estimation horizon. However, the financial crisis might to some extent change the pattern.

5.6 Concluding Remarks

In this chapter, we investigated the sources of foreign exchange exposure for a large panel of UK-listed non-financial firms in the period 1990-2011. To be specific, firm-level foreign exchange betas are decomposed into cash flow components and discounted rate components based on the return decomposition framework of Campbell and Shiller (1998) as well as that by Campbell (1991).

This analysis yields three main results. Firstly, the variance in cash flows is the main drive of the total variance of stock prices, since it accounts for more than 80% of the total variance. This result is robust to variable measurement, model specification, and estimation sample and it is consistent with the main research on stock return decomposition, such as Campbell (1991), Campbell and Mei (1993), Vuolteenaho (2002), Campbell and Vuolteenaho (2004), Campbell, Polk & Vuolteenaho (2010), among many others.

Secondly, decomposition can dramatically increase the levels of significance of foreign exchange exposures. Whether modelling discounted rate news directly and using residuals to compute cash flow news, or modelling both cash flow news and discounted rate news directly, the sensitivities of cash flows and discounted rate news with respect to foreign exchange rates are significant. However, there is less significant evidence for foreign exchange rate exposure as a whole. This might offer another explanation for the foreign exchange rate puzzle. In theory, significant currency exposure is actually the sensitivities of cash flows with respect to exchange rate. However, empirical studies usually employ stock prices as a proxy for cash flows due to the latter's unavailability. Since the sensitivities of stock prices to exchange rates should actually equal the overall impact of both cash flow news and discounted rates, which can be offset by each other, there is always a low level of significance for foreign exchange exposure in empirical studies.

Thirdly, in terms of the components of foreign exchange betas, foreign exchange exposure via the discounted rate channel on average outweighs the effect via the cash flow channel in the period 1990-2011. This implies that the transitory effect of discounted rates ("good" beta) outweighs the permanent effect of cash flows ("bad" beta), and this discounted rate channel helps firms to bear the brunt of currency exposure by offering positive investment opportunities in the future. However, during the period 1990-2008, the foreign exchange effect via the discounted rate channel could not outweigh the impact via the cash flow channel, which suggests that the effect of the discounted rate channel increases dramatically during a financial crisis. This is mainly due to the illiquidity of the assets and higher required return asked by investors during financial crisis. Generally speaking, our findings based on normal period are consistent with the results in previous chapters when financial crisis is controlled by a dummy variable. In other words, it is the "bad" cash flow beta that outweighs the "good" discounted rate beta in normal period.

Overall, this chapter employs the return decomposition framework to distinguish anticipated and unanticipated parts of changes in foreign exchange rates when examining the interaction between foreign exchange rates and stock prices research, and this offers a new insight into the foreign exchange puzzle and provides the sources of foreign exchange exposure. In addition, the decomposition of foreign exchange rate betas can then be easily extended to risk pricing analysis, time-varying risk model and other applications.

Appendix 5.A: Diagnostic checks

Test	Methodology	Results and solution
Unit root tests	Fisher-type unit-root tests for all variables in the regressions	All the variables are stationary
Homoscedasticity tests	Breusch-Pagan / Cook-Weisberg tests	Heteroskedasticity
Multicollinearity tests	Variance inflation factors	No multicollinearity
Model specification tests (1)	Model specification link test for single-equation models	Correct specification
Model specification tests (2)	Regression specification error test (RESET) for omitted variables	No omitted variables

Notes:

1. All the tests are conducted for the whole sample for the period 1990-2011.

Appendix 5. B1: Alternative VAR parameter estimates

	$\widetilde{r_{\iota,t-1}}$	$\widetilde{BM_{\iota,t-1}}$	$\widetilde{ROE_{\iota,t-1}}$	$r_{fx2,t-1}$	R^2	Joint sig.
$\widetilde{ROE_{\iota,t}}$	0.115***	0.0413***	0.688***	-0.0742	0.495	298.23***
	(0.0304)	(0.0115)	(0.0205)	(0.151)		
$\widetilde{r_{\iota,t}}$	0.0261	0.0165***	0.0129**	-0.880***	0.0264	36.85***
	(0.0174)	(0.00548)	(0.00533)	(0.0768)		
$\widetilde{BM_{\iota,t}}$	-0.0614***	0.901***	0.0236***	0.0352	0.839	6068.83***
	(0.0150)	(0.00588)	(0.00419)	(0.0830)		
$r_{fx2,t}$	0.0124***	0.00274**	-0.00214**	0.0681***	0.0117	18.99***
	(0.00217)	(0.00108)	(0.000914)	(0.0124)		

Notes:

1. This table shows the parameter estimates for the first-order firm-level VAR model using the weighted least square (WLS) estimator. The state variables included in this VAR specification are log return on equity ($\widetilde{ROE_{\iota}}$), log firm-level stock return ($\widetilde{r_{\iota}}$), log book-to-market ratio ($\widetilde{BM_{\iota}}$), and log return on real trade-weighted exchange rate (r_{fx2}). The three firm specific variables are winsorised to deal with extreme values, and demeaned by subtracting their cross-sectional means from log book-to-market ratio ($\widetilde{BM_{\iota}}$), log return on equity ($\widetilde{ROE_{\iota}}$), and subtracting the return on market index for non-financial firms from log firm-level stock return ($\widetilde{r_{\iota}}$).

2. Rows correspond to the dependent variables, and the independent (lagged dependent) ones are tabled in columns. The point coefficient estimates are shown in the first four columns, and the Heteroskedasticity-corrected standard deviations are presented in parentheses. The fifth column reports the corresponding R^2 for each equation in our VAR specification. The last column presents the F-statistics for joint significance levels of the VAR forecast variables.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5. B2: Variance-covariance matrix of CF and DR news under alternative VAR

	$\widetilde{e_{e\imath}}$	$\widetilde{e_{d\imath}}$
$\widetilde{e_{e\imath}}$	0.0053	
$\widetilde{e_{d\imath}}$	0.0332	0.7754

Notes:

1. This table shows the variance-covariance matrix of the two components of unexpected firm-level returns, discounted rate news ($\widetilde{e_{e\imath}}$) and cash flow news ($\widetilde{e_{d\imath}}$). We employ two separate VARs to model both discount rate news and cash flow news directly. The VAR used to predict discount rate news includes the same variables in the main result, while the VAR used to predict cash flow news includes log return on equity, log firm-level stock return, log book-to-market ratio and log return on real trade-weighted foreign exchange rate. The two components are calculated by equation (10) and (12), respectively.
2. The sample period for the dependent variable is 1990-2011, resulting in 780 UK firms consisting 7129 firm-year observations.

Appendix 5. B3: Decomposition of foreign exchange beta for alternative VAR

Industry	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
Agriculture, Forestry and Fishing	-0.3787	2.6023	-0.7437***	87
	(0.5503)	(2.6824)	(0.1404)	
Mining	-0.0964	-1.1927	-0.8555***	187
	(0.4597)	(1.1369)	(0.0780)	
Construction	1.2610**	0.7792	-0.9053***	248
	(0.4130)	(0.7377)	(0.0501)	
Manufacturing	0.0011	0.0458	-0.8318***	2286
	(0.1094)	(0.2446)	(0.0145)	
Transportation, Communications, Electric, Gas and Sanitary Services	0.4193*	0.3275	-0.8355***	495
	(0.2236)	(0.4126)	(0.0274)	
Wholesale Trade	-0.0636	0.6808	-0.8032***	318
	(0.3443)	(0.7293)	(0.0339)	
Retail Trade	0.3951*	-0.3608	-0.8732***	609
	(0.2290)	(0.5229)	(0.0320)	
Finance, Insurance and Real Estate	-0.3231	-1.5185*	-0.9227***	121
	(0.3947)	(0.8834)	(0.0687)	
Services	1.2826***	0.4085	-0.8555***	1184
	(0.2033)	(0.4147)	(0.0247)	
Public Administration	-7.4714	18.2172**	1.8762	3

	(12.1264)	(1.1330)	(1.0173)	
Industry average	0.3698***	0.1670	-0.8432***	5538
	(0.0783)	(0.1706)	(0.0102)	

Notes:

1. This table shows the decomposition of the real foreign exchange betas of ten industries in the UK. $\beta_{i,fx}$ is total stock return sensitivity to foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to foreign exchange rates, $\beta_{ei,fx}$ is sensitivity of discounted rate news to foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the real foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7).
2. N refers to the number of observations from each industry. Both cash flow and discount rate news are obtained directly from separate VAR models. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2011, with 5538 firm-year observations for 663 companies in the UK.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5. B4: Decomposition of foreign exchange beta as a function of size for alternative VAR

Size	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
1	0.5039*	-0.6884	-0.8737***	551
	(0.2699)	(0.6455)	(0.0332)	
2	0.3976*	-0.0854	-0.8627***	834
	(0.2164)	(0.4055)	(0.0238)	
3	0.3525**	0.3302	-0.8481***	1384
	(0.1687)	(0.3156)	(0.0188)	
4	0.3488**	0.4387	-0.8410***	1385
	(0.1496)	(0.3836)	(0.0230)	
5	0.3445**	0.1171	-0.8094***	832
	(0.1736)	(0.3925)	(0.0249)	
6	0.3243	0.3882	-0.8217***	552
	(0.2006)	(0.4010)	(0.0302)	

Notes:

1. This table shows the decomposition of the real foreign exchange betas as a function of firms' size. Size is defined as log form of the total assets. Size 1 refers to the smallest firms, whose total assets are below the 10th percentile of total assets, size 6 contains large firms whose total assets are beyond the 90th percentile of total assets. The remaining size portfolios are firms whose total assets are between the 10th 25th percentile, 25th and 50th percentile, 50th and 75th percentile and 75th percentile and 90th percentile for sizes 2, 3, 4, 5 respectively. $\beta_{i,fx}$ is total stock return sensitivity to foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to foreign exchange rates, $\beta_{ei,fx}$ is

sensitivity of discounted rate news to foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the real foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7).

2. N refers to the number of observations in each industry. Both cash flow and discount rate news are obtained directly from separate VAR models. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2011, with 5538 firm-year observations for 663 companies in the UK.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5.C1: Firm VAR parameter estimation over a subsample (year<2008)

	$\widetilde{r_{\iota,t-1}}$	$\widetilde{BM_{\iota,t-1}}$	$\widetilde{ROE_{\iota,t-1}}$	$r_{fx2,t-1}$	R^2	Joint sig.
$\widetilde{r_{\iota,t}}$	0.0272	0.0137**	0.0145**	-1.119***	0.0421	45.79***
	(0.0195)	(0.0055)	(0.0058)	(0.0875)		
$\widetilde{BM_{\iota,t}}$	-0.0793***	0.910***	0.0188***	-0.0071	0.876	5899.19***
	(0.0159)	(0.0061)	(0.0044)	(0.0937)		
$\widetilde{ROE_{\iota,t}}$	0.109***	0.0582***	0.710***	-0.0729	0.536	262.72***
	(0.0364)	(0.0118)	(0.0224)	(0.169)		
$r_{fx2,t}$	0.001	0.0009	-0.0019*	-0.0574***	0.00449	6.14***
	(0.0026)	(0.0012)	(0.001)	(0.0125)		

Notes:

1. This table shows parameter estimates for the first-order firm-level VAR model using the weighted least square (WLS) estimator. The state variables included in this VAR specification are log firm-level stock return ($\widetilde{r_\iota}$), log book-to-market ratio ($\widetilde{BM_\iota}$), log return on equity ($\widetilde{ROE_\iota}$) and log return on real trade-weighted exchange rate (r_{fx2}). The three firm specific variables are winsorised to deal with extreme values, and demeaned by subtracting their cross-sectional means from log book-to-market ratio ($\widetilde{BM_\iota}$), log return on equity ($\widetilde{ROE_\iota}$), and subtracting the return on market index for non-financial firms from log firm-level stock return ($\widetilde{r_\iota}$).
2. Rows correspond to the dependent variables, and the independent (lagged dependent) ones are tabled in columns. The point coefficient estimates are

shown in the first four columns, and the Heteroskedasticity-corrected standard deviations are presented in parentheses. The fifth column reports the corresponding R^2 for each equation in our VAR specification. The last column presents the F-statistics for joint significance levels of the VAR forecast variables.

3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5. C2: Variance-covariance matrix of CF and DR news over a subsample (year<2008)

	$\widetilde{e_{e\iota}}$	$\widetilde{e_{d\iota}}$
$\widetilde{e_{e\iota}}$	0.0057	
$\widetilde{e_{d\iota}}$	0.0079	0.1360

Notes:

1. This table shows the variance-covariance matrix of the two components of unexpected firm-level returns, discounted rate news ($\widetilde{e_{e\iota}}$) and cash flow news ($\widetilde{e_{d\iota}}$), using the four state variable VAR model from Appendix 5.C1. The VAR model includes log firm-level stock return, log book-to-market ratio, log return on equity and log return on real trade-weighted foreign exchange rate. The two components are calculated by equations (5.10) and (5.11) in Section 5.3.3.
2. The sample period for the dependent variable is 1990-2008, resulting in 642 UK firms consisting 5453 firm-year observations.

Appendix 5.C3: Decomposition of foreign exchange beta (year<2008)

Industry	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
Agriculture, Forestry and Fishing	-1.2453**	-2.1625***	-0.9173***	69
	(0.5363)	(0.500)	(0.1496)	
Mining	-1.2489***	-2.1659***	-0.9170***	130
	(0.4543)	(0.45867)	(0.1017)	
Construction	0.1513	-0.7993	-0.9505***	204
	(0.4715)	(0.4878)	(0.0556)	
Manufacturing	-0.7388***	-1.737***	-0.9982***	1812
	(0.1126)	(0.1128)	(0.0168)	
Transportation, Communications, Electric, Gas and Sanitary Services	-0.1476	-1.1253***	-0.9778***	361
	(0.2355)	(0.2336)	(0.0316)	
Wholesale Trade	-0.7980**	-1.7865***	-0.9885***	279
	(0.3738)	(0.3754)	(0.0338)	
Retail Trade	-0.3303	-1.4311***	-1.1008***	481
	(0.2314)	(0.2333)	(0.0330)	
Finance, Insurance and Real Estate	-1.0760**	-2.1170***	-1.0410***	92
	(0.4556)	(0.4772)	(0.0595)	
Services	-0.1115	-1.1524***	-1.0409***	757
	(0.2669)	(0.2724)	(0.0386)	
Industry average	-0.5552***	-1.5624***	-1.0072***	4185

	(0.0839)	(0.0845)	(0.0120)

Notes:

1. This table shows the decomposition of the real foreign exchange betas of ten industries in the UK. $\beta_{i,fx}$ is total stock return sensitivity to foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to foreign exchange rates, $\beta_{ei,fx}$ is sensitivity of discounted rate news to foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the real foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7).
2. N refers to the number of observations from each industry. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2008, with 4185 firm-year observations for 558 companies in the UK.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5.C4: Decomposition of foreign exchange beta as a function of size (year<2008)

Size	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
1	-0.5350*	-1.5455***	-1.0104***	424
	(0.2813)	(0.2806)	(0.0441)	
2	-0.3277	-1.3112***	-0.9835***	651
	(0.2430)	(0.2412)	(0.0316)	
3	-0.7461***	-1.7472***	-1.0011***	1059
	(0.1853)	(0.1883)	(0.0232)	
4	-0.5846***	-1.6059***	-1.0213***	1032
	(0.1498)	(0.1525)	(0.0230)	
5	-0.6714***	-1.6698***	-0.9984***	628
	(0.1698)	(0.1729)	(0.0322)	
6	-0.0700	-1.1126***	-1.0426***	391
	(0.1986)	(0.1952)	(0.0302)	

Notes:

1. This table shows the decomposition of the real foreign exchange betas as a function of firms' size. Size is defined as log form of the total assets. Size 1 refers to the smallest firms, whose total assets are below the 10th percentile of total assets, size 6 contains large firms whose total assets are beyond the 90th percentile of total assets. The remaining size portfolios are firms whose total assets are between the 10th and 25th percentile, 25th and 50th percentile, 50th and 75th percentile and 75th and 90th percentile for sizes 2, 3, 4, 5, respectively. $\beta_{i,fx}$ is total stock return sensitivity to foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to foreign exchange rates, $\beta_{ei,fx}$ is sensitivity of discounted

rate news to foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the real foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7).

2. N refers to the number of observations from each industry. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2008, with 4185 firm-year observations for 558 companies in the UK.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5.D1: Firm VAR parameter estimation using nominal exchange rates

	$\widetilde{r_{\iota,t-1}}$	$\widetilde{BM_{\iota,t-1}}$	$\widetilde{ROE_{\iota,t-1}}$	$r_{fx1,t-1}$	R^2	Joint sig.
$\widetilde{r_{\iota,t}}$	0.0250	0.0166***	0.0128**	-0.814***	0.0244	33.47***
	(0.0174)	(0.00549)	(0.00533)	(0.0749)		
$\widetilde{BM_{\iota,t}}$	-0.0613***	0.901***	0.0236***	0.0388	0.839	6069.94***
	(0.0150)	(0.00588)	(0.00419)	(0.0809)		
$\widetilde{ROE_{\iota,t}}$	0.115***	0.0413***	0.688***	-0.0631	0.495	298.15***
	(0.0304)	(0.0115)	(0.0205)	(0.148)		
$r_{fx1,t}$	0.0120***	0.00288**	-0.00211**	0.0992***	0.0161	23.21***
	(0.00226)	(0.00112)	(0.000947)	(0.0141)		

Notes:

1. This table shows parameter estimates for the first-order firm-level VAR model using the weighted least square (WLS) estimator. The state variables included in this VAR specification are log firm-level stock return ($\widetilde{r_\iota}$), log book-to-market ratio ($\widetilde{BM_\iota}$), log return on equity ($\widetilde{ROE_\iota}$) and log return on nominal trade-weighted exchange rate (r_{fx1}). The three firm specific variables are winsorised to deal with extreme values, and demeaned by subtracting their cross-sectional means from log book-to-market ratio ($\widetilde{BM_\iota}$), log return on equity ($\widetilde{ROE_\iota}$), and subtracting the return on market index for nonfinancial firms from log firm-level stock return ($\widetilde{r_\iota}$).
2. Rows correspond to the dependent variables and the independent (lagged dependent) ones are tabled in columns. The point coefficient estimates are

shown in the first four columns, and the Heteroskedasticity-corrected standard deviations are presented in parentheses. The fifth column reports the corresponding R^2 for each equation in our VAR specification. The last column presents the F-statistics for joint significance levels of the VAR forecast variables.

3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level

Appendix 5.D2: Variance-covariance matrix of CF and DR news using nominal exchange rates

	$\widetilde{e_{e\imath}}$	$\widetilde{e_{d\imath}}$
$\widetilde{e_{e\imath}}$	0.0052	
$\widetilde{e_{d\imath}}$	0.0036	0.1483

Notes:

1. This table shows the variance-covariance matrix of the two components of unexpected firm-level returns, discounted rate news ($\widetilde{e_{e\imath}}$) and cash flow news ($\widetilde{e_{d\imath}}$), using the four state variable VAR model from Appendix 5.D1. The VAR model includes log firm-level stock return, log book-to-market ratio, log return on equity and log return on nominal trade-weighted foreign exchange rate. The two components are calculated by equations (5.10) and (5.11) in Section 5.3.3.
2. The sample period for the dependent variable is 1990-2011, resulting in 780 UK firms consisting 7129 firm-year observations.

Appendix 5.D3: Decomposition of foreign exchange beta using nominal exchange rates

Industry	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
Agriculture, Forestry, And Fishing	-0.4071	-1.0998**	-0.6927***	87
	(0.5464)	(0.5424)	(0.1352)	
Mining	-0.1247	-0.9471**	-0.8224***	187
	(0.4577)	(0.4600)	(0.0758)	
Construction	1.1459***	0.2803	-0.8655***	248
	(0.4061)	(0.4074)	(0.0488)	
Manufacturing	-0.0073	-0.8012***	-0.7939***	2286
	(0.1067)	(0.1073)	(0.0139)	
Transportation, Communications, Electric, Gas, And Sanitary Services	0.4192*	-0.3795*	-0.7986***	495
	(0.2181)	(0.2169)	(0.0263)	
Wholesale Trade	-0.0518	-0.8106**	-0.7588***	318
	(0.3360)	(0.3428)	(0.0327)	
Retail Trade	0.3747*	-0.4559**	-0.8306***	609
	(0.2245)	(0.2265)	(0.0306)	
Finance, Insurance, And Real Estate	-0.3353	-1.2231***	-0.8878***	121
	(0.3904)	(0.3979)	(0.0658)	
Services	1.2822***	0.4603**	-0.8220***	1184
	(0.1967)	(0.1972)	(0.0241)	
Public Administration	-5.4478	-3.7930	1.6548***	3

	(12.0219)	(10.8792)	(1.1426)	
Industry average	0.3566***	-0.4487***	-0.8053***	5538
	(0.0762)	(0.0765)	(0.0098)	

Notes:

1. This table shows the decomposition of the nominal foreign exchange betas of ten industries in UK. $\beta_{i,fx}$ is total stock return sensitivity to nominal foreign exchange rates, $\beta_{di,fx}$ is sensitivity of cash flow news to nominal foreign exchange rates, $\beta_{ei,fx}$ is sensitivity of discounted rate news to nominal foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the nominal foreign exchange betas. Betas are obtained from equations (5.5), (5.6) and (5.7).
2. N refers to the number of the observations from each industry. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2011, with 5538 firm-year observations for 663 companies in the UK.
3. * Significant at a 10% level, ** significant at a 5% level, and *** significant at a 1% level.

Appendix 5.D4: Decomposition of foreign exchange beta as a function of size using nominal exchange rates

Size	$\beta_{i,fx}$	$\beta_{di,fx}$	$\beta_{ei,fx}$	N
1	0.5030*	-0.3318	-0.8347***	551
	(0.2628)	(0.2627)	(0.0318)	
2	0.3849*	-0.4390**	-0.8239***	834
	(0.2089)	(0.2069)	(0.0229)	
3	0.3158*	-0.4945***	-0.8103***	1384
	(0.1643)	(0.1648)	(0.0182)	
4	0.3370**	-0.4631***	-0.8001***	1385
	(0.1452)	(0.1474)	(0.0221)	
5	0.3434**	-0.4320**	-0.7754***	832
	(0.1707)	(0.1722)	(0.0240)	
6	0.3401*	-0.4487**	-0.7888***	552
	(0.1956)	(0.1954)	(0.0294)	

Notes:

1. This table shows the decomposition of the nominal foreign exchange betas as a function of firms' size. Size is defined as log form of the total assets. Size 1 refers to the smallest firms, whose total assets are below 10th percentile of total assets, size 6 contains the large firms whose total assets are beyond 90th percentile of total assets. The remaining size portfolios are firms whose total assets between 10th percentile and 25th percentile, 25th percentile and 50th percentile, 50th percentile and 75th percentile, 75th percentile and 90th percentile for size 2, 3, 4, and 5, respectively. $\beta_{i,fx}$ is the total stock return sensitivity to the foreign exchange rates, $\beta_{di,fx}$ is the sensitivity of cash flow

news to the foreign exchange rates, $\beta_{ei,fx}$ is the sensitivity of discounted rate news to the foreign exchange rates. $\beta_{di,fx}$ and $\beta_{ei,fx}$ are the two components of the nominal foreign exchange betas. Betas are obtained from equation (5.5), (5.6) and (5.7).

2. N refers to the number of the observations in each industry. All figures in parenthesis are Heteroskedasticity-corrected standard errors. The sample period covers 1990 to 2011, with 5538 firm-year observations for 663 companies in UK.
3. * Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level.

CHAPTER 6

CONCLUSION

6.1 Summary

This thesis investigates the interaction between exchange rates and stock prices at micro level, both theoretically and empirically, with reference to a large panel consisting of all UK non-financial firms over a period between 1990 and 2011. It is one of the first studies to trace the transmission channels through which changes in exchange rates pass-through into stock prices. Although there is abundant research that demonstrates the impact of exchange rates on equity prices, there is no study showing how and why this effect occurs. The transmission channels identified in the theoretical framework provide insights into the relation between exchange rates and stock prices. This thesis then employed an empirical equation to confirm the mechanism through which foreign exchange rates affect equity prices. Furthermore, the impact of firms' characteristics on these transmission channels is also investigated in order to show why there is a relatively higher exposure for certain types of firm. In addition, this thesis employed return decomposition to study the effects of unanticipated changes in foreign exchange rates on stock prices. It therefore provides more consistent and accurate measurement of foreign exchange rate exposure compared to previous studies, as financial theory suggests.

This chapter concludes the whole thesis. The key findings are summarised in Section 6.2, with the main contributions and practical implications following in Section 6.3, and the limitations of this research as well as its implications for future research given in Sections 6.4 6.5 respectively.

6.2 Key findings and conclusions

6.2.1 Transmission channels—theoretical evidence

The comprehensive literature review shows that there are many studies investigating the relationship between exchange rates and stock prices both at micro and macro level. At micro level, researchers are interested in the exposure of firms to fluctuations in exchange rates. However, there is no research that offers any insights into how these rates affect stock prices. In other words, as existing studies have already discussed the question of whether foreign exchange rate risk will be priced in stock price, there are no articles asking how and why do foreign exchange rates have an impact on equity prices?

To fill this gap, Chapter 3 interrogates the pass-through effect of exchange rates by tracing the transmission channels through which foreign exchange rates influence stock prices. We begin with a basic definition of currency exposure and theoretically examine transmission channels. As research suggests, foreign exchange rate exposure is defined as assets' value sensitivity to changes in foreign exchange rates. Therefore calculation of theoretical foreign exchange rate exposure from this definition requires valuation of share prices. After reviewing the popular share valuation models in accounting literature, three widely used ones are chosen to examine foreign exchange rate exposure: the Discounted Dividend model, the Free Cash Flow model and the Residual Income model. Partial derivatives of each share valuation model with regard to exchange rates are employed, in order to obtain theoretical currency exposure. Finally, different transmission channels are identified. The Discounted Dividend model shows that stock prices are sensitive to foreign exchange rates because of cost of equity, which is the only channel for stock price sensitivity to exchange rates. The Residual Income model suggests that stock prices should respond to exchange rates through two channels: company earnings or cost of capital. Besides the positive cost of capital channel (if cost of equity increases as a result of currency appreciation), the Residual Earnings model also indicates a negative channel through company's earnings, if they are positively related to exchange rates. In terms of the Free Cash Flow model, changes in exchange rate pass-through into stock price can be decomposed into elasticities of cash flow from operations, cash investments and cost of capital for a firm, with regard to exchange rates. Furthermore, cash investments and cash flow from operations can be regarded as cash flow channels. In addition, the magnitude of the effect of each channel depends on its response to exchange rates.

Unbalanced panel data at firm-level consisting of 3515 observations for 421 non-financial companies is employed for model calibration. After calibrating each parameter in theoretical currency exposure, some useful economic implications are highlighted. Firstly, there is a huge difference in total currency exposure if different valuation models are employed. The Discounted Dividend model suggests that total stock price elasticities to exchange rates are around 0.98, with little difference across industries. In other words, when valuing equities using the Discounted Dividend model, there is almost complete pass-though for changes in foreign exchange rates to stock prices. However, price sensitivities based on the Residual Earnings model are highest (1.266), indicating that the foreign exchange rate pass-through effect is more than complete. The Free Cash Flow model suggests little impact of exchanges rates on stock prices, with overall stock price sensitivity to exchange rates at only -0.03. The huge differences between the implications of the Discounted Dividend model and the other two models might be explained by an addition channel, either the cash flow channel or the earnings channel, suggested by both the Free Cash Flow Residual Income models. Furthermore, the reason why overall stock price sensitivity based on the Free Cash Flow and Residual Income models is so different is that the accruals in accounting can make cash flows very different the net income during that period. The sources of this overall price sensitivity function as follows. The Discounted Dividend model suggests that 100% of stock price sensitivity should result from the impact of cost of equity. Based on the Free Cash Flow model, more than 85% of stock price sensitivity is from companies' cash flows including cash flows from operations and cash investments; only less than 15% of share price elasticity is associated with the cost of equity used in share valuation modeling. In terms of the Residual Income model, earnings can explain more than 90% of overall stock price sensitivity, and around 10% or less of share price elasticity is from cost of equity. Finally, an important point about stock price reaction to exchange rate movements is the degree of economic flexibilities in earnings, cash flows and cost of equity, which are often fundamentally different across firms.

6.2.2 Transmission channels and firm characteristics—empirical evidence

Chapter 3 provides the evidence of how and why stock prices are affected by foreign exchange rates from a theoretical point of view. However, there is no empirical evidence to demonstrate its usefulness in economic reality. To address this gap, Chapter 4 extends the work to form an empirical model which examines exchange rate pass-through effect empirically, using unbalanced panel data at firm-level, consisting of 3515 observations for 421 non-financial companies between 1990 and 2011. Empirical studies have found mixed results of total foreign exchange rate exposure when using firm-level data. Previous research has found that firm characteristics are important determinants this exposure, but the question of how these characteristics affect it has not yet been researched. To fill this gap, Chapter 4 will investigate the effect of these firm characteristics on the transmission channels identified in Chapter 3, in addition to the empirical evidence. Chapter 4 will thus examine whether some transmission channels only perform for particular types of company, leading to various exchange rate exposures across different companies. In particular, firms' size, leverage ratio and foreign sales ratio are included in the analysis, since they are found to be significant determinants for currency exposure.

Based on the testable implications provided by the theoretical framework in Chapter 3, Chapter 4 specifies two dynamic stock price equations for econometric analysis, using the Free Cash Flow and Residual Income models respectively. The interaction items of the exchange rate with cost of capital, earnings or cash flow in the equations are the essential elements for appraising pass-through effect. Therefore, by interacting exchange rate, x_t, with these firm-specific, time-varying variables, the empirical specifications allow the effect of exchange rates on stock prices to vary over time and across firms, depending on the possible transmission channels identified in the theoretical framework. Due to its dynamic nature and the endogenous problem, this model is estimated using the advanced techniques system GMM estimator. In addition, firms are divided into subsamples according to their size, leverage ratio and foreign sales ratio respectively, in order to empirically study the impact of their characteristics on transmission channels.

In general, the econometric results in Chapter 4 support the view that exchange rate fluctuations have a significant impact on stock prices through changes in cost-side (cost of capital) and revenue side (cash flows or earnings). In particular, exchange rate depreciation, as measured by reduction of trade-weighted exchange rates, induces stock price increase through the revenue-side channel (earnings or free cash flows), and a decrease through the cost-side channel (cost of capital). Moreover, the coefficients associated with the revenue-side channel (earnings or cash flows) are always larger than those associated with the cost-side channel (cost of capital), suggesting that permanent "bad" effects outweigh transitory "good" ones. In other words, foreign exchange exposure via the revenue-side channel on average outweighs the effect via the cost of capital channel, so that future investment opportunities are reduced. Furthermore, the effect stemming from the cost of capital side increases in absolute value, as a result of higher cost of capital for a firm, while the effect through the revenue-side channel increases with the growing net income or cash flows for a firm. The size of the effects through the cost of capital and earnings/free cash flow channels are also discussed in Chapter 4. The Residual Earnings model suggests that a 1% depreciation in exchange rates should lead to a 0.867% increase in stock prices for a hypothetical firm exhibiting these median values. The Free Cash Flow model suggests a 0.961% increase in stock prices due to a 1% depreciation in trade-weighted exchange rates. Finally, the impact of firm characteristics on transmission channels is also revealed. Firms' size is suggested to be positively related to the effect of the earnings channel and net elasticity. Similarly, results show the positive relationship between foreign exchange exposure and foreign sales ratio. However, there is a negative relationship between exchange rate pass-through effect and firms' leverage ratio.

6.2.3 The sources of unanticipated foreign exchange exposure

Research shows that currency exposure, usually defined as foreign exchange beta, is central to individual investors and firms. However, measurement of this exposure is flawed in previous studies. Specifically, although finance theory suggests that the expected changes should have little effect on assets and that they should already be priced into assets, (Bredin & Hyde, 2011) the majority of previous studies of foreign exchange exposure adopt realized changes in exchange rates as the proxy of unexpected changes (See, for example, Choi and Prasad, 1995; Carrieri, Errunza & Majerbi, 2006; Bartram, 2007; Choi & Jiang, 2009; among many others). Therefore, Chapter 5 will clarify this measurement and make a new attempt to study firms' unanticipated currency exposure. Moreover, given the importance of foreign exchange betas, it is natural to ask how beta is determined. Although there is abundant research on the magnitude of foreign exchange exposure, there is little evidence of the sources of exchange rate exposure. Therefore, Chapter 5 will attempt to find out where unexpected foreign exchange risk comes from.

A firm-level first order vector autoregressive (VAR) model and Campbell's return decomposition framework are employed to study firms' foreign exchange risks, based on a large unbalanced panel of UK-listed non-financial firms for the period 1990-2011. This advanced return decomposition framework enables us to decompose the foreign exchange betas into two components: foreign exchange betas of cash flows, and foreign exchange betas of discounted rates. In our VAR specification, log firm-level return, log book-to-market ratio, log long term profitability (ROE) and log foreign exchange rates are included as state variables, following the approach of Campbell, Polk and Vuolteenaho (2010) to firm-level VARs. Foreign exchange rate is inserted as an additional variable since there is abundant research showing how important this rate can be in explaining stock prices. This methodology is similar to the development of the two-factor model (international CAPM) from the classic market model. Foreign exchange betas are calculated from the covariance of innovations in returns and factors divided by the factor innovation's unconditional variances. In addition, the entire sample is divided into different industry groups and size portfolios. This exclusive research can shed light on and provide a ground-breaking understanding of firms' foreign exchange risks.

The main findings of this new research idea can be summarized as follows. Firstly, cash flow variance is the main driver of total stock price variance, since it accounts for more than 80% of total variance. Secondly, decomposition can dramatically increase the foreign exchange exposure levels. Even though the total currency exposure is insignificant, both cash flow component and discounted rate components are found to be statistically significantly affected by changes in foreign exchange rates. Thirdly, in terms of the magnitude of the components of foreign exchange betas, foreign exchange exposure via the discounted rate channel on average outweighs the effect via the cash flow channel, during the period 1990-2011. This implies that the transitory effects of discounted rates (“good” beta) outweigh the permanent effects of cash flows (“bad” beta), and this discounted rate channel helps firms to bear the brunt of currency exposure by offering positive investment opportunities for the future. However, during the period 1990-2008, this result changed. Foreign exchange effect via the discounted rate channel cannot outweigh the impact via the cash flow channel, which implies that the effect of the former increases dramatically during financial crises. This is mainly due to the illiquidity of assets and increased required return asked by investors during financial crisis time. In normal periods, the effect is consistent with the implications of our theoretical framework. In addition, evidence of the impact of industry and size on beta decomposition is also provided. One feature worth noting is that stable industries such as the service industry, retail trade industry, transportation, communications, electric, gas, and sanitary services industry have relatively lower cash flow betas. On the other hand, for cyclical industries such as mining, manufacturing, finance, insurance, and real estate, cash flows are much more sensitive to the business cycle, and thus have higher cash flow betas. Another point is that cash flows are less significantly exposed to foreign exchange risk in small stocks than in large ones. In particular, the absolute values of betas for discounted rates decline almost monotonically with size. All these results are robust to the alternative VAR system and other foreign exchange rate measurements.

6.3 Main contributions and practical implications

This thesis aims to address the lacunae in the relationship between exchange rates and stock prices at micro level identified in existing research, by tracing the transmission channels through which changes in exchange rate pass-through into stock prices, using a large unbalanced panel of data from firm-level consisting of 3515 observations for 421 non-financial companies during the period 1990 to 2011. Based on the definition of foreign exchange rate exposure in finance theory and of share valuation models in accounting theory, we develop a theoretical framework of stock price elasticity with regard to exchange rates. The transmission channels are then identified. Furthermore, an empirical specification based on theoretical implications is given, in order to provide empirical evidence for the identified transmission channels, as well as of the effect of firm characteristics on these pass-though channels. Finally, unanticipated changes in foreign exchange rates are distinguished from expected ones, in order to offer an examination of unexpected foreign exchange rate exposure. This comprehensive work thus provides insightful evidence of the interaction between exchange rates and stock prices at micro level, and greatly enhances our understanding of foreign exposure.

The main contributions of this thesis can be summarized as follows. Firstly, to the best of our knowledge, this study makes the first attempt to provide detailed evidence of how and why exchange rates affect the stock prices, since it has already been clearly proved that foreign exchange risk is priced in equity price. More importantly, by tracing and quantifying the transmission channels through which changes in exchange rates pass-through into stock prices, we give an insight into the relationship between exchange rates and stock prices at micro level.

Secondly, this work bridges a gap between two common areas in accounting and finance: share valuation models in accounting literature, and foreign exchange rate exposure in the financial area. This study begins with share valuation models, and employs the pass-through effect deviation in economic research to analyze foreign exchange rate exposure in finance. This new methodology allows us to measure stock price exposure theoretically. Previous theoretical currency exposure is based on cash flows rather than stock prices. However, stock prices are not only determined by cash flows, but also by discounted rates. Therefore, previous studies which gave a definition based only on cash flows might have provided a misleading explanation of the interaction between exchange rates and stock prices.

Thirdly, this thesis provides an explanation of the currency exposure puzzle from a new angle. The foreign exchange rate puzzle is the name given to the low level of significant exposures found in empirical studies, although financial theory suggests that exposure is present because of unexpected changes in cash flows. Research appears to explain this puzzle by either shortcomings in estimation methodology or corporation hedging activities. However, in this study, we employ the Campbell-Shiller approximation of expected returns to examine the components of return exposure, including future cash flow components and discount rate components (future excess return components). Thus, the complementary effects between future cash flow and future excess return effects provide an additional explanation for the foreign exchange rate puzzle.

Fourthly, this thesis offers new evidence about the effect of firm characteristics on exchange rate pass-through channels. It contributes to research by explaining why not all firms are exposed to exchange rate fluctuations to the same extent.

Furthermore, a more precise measurement of currency exposure using unanticipated changes in exchange rate rather than actual changes is provided. Realized changes in exchange rates as a proxy of unexpected changes are suggested to be an inappropriate measurement. Finance theory suggests that expected changes should have little effect on assets and should already be priced into assets (Bredin & Hyde, 2011). As a result, the unanticipated parts of changes in foreign exchange rates should be separated from the expected ones, so that only the former is used when examining currency exposure.

In addition, this thesis contributes to existing studies by adding new evidence on foreign exchange betas, which are very useful measurements in modern finance. Academics and practitioners employ betas to model and control non-diversifiable risk, and also use determinants for expected returns in the asset pricing model such as the capital asset pricing model (CAPM), intertemporal CAPM and arbitrage pricing models (Campbell and Mei, 1993). Thus, an investigation of foreign exchange rate exposure in terms of decomposing foreign exchange beta can be easily extended to risk pricing analysis and the, time-varying risk model., revealing the origin of foreign exchange exposure.

The conclusions from this thesis have practical implications for risk managers, policy makers, investors and researchers. For risk managers, understanding of the foreign exchange rate risk is enhanced. Realizing the dynamic offset impact of exchange rates through the cash flow and discounted rate components can reduce the amount used to hedge for equity value. For policy makers, since the impact of unexpected changes in exchange rates on cash flows can be compensated by the effect on firms through discounted-rate channel; the pressure to change foreign exchange rate policy is mitigated. For investors, a more profitable investment strategy can be considered when exchange rates fluctuate. For researchers, they can employ this decomposed foreign exchange beta to carry out risk pricing analysis and other research.

6.4 Limitations of the research

It is worth noting that there are some limitations to this thesis. Firstly, it only employs stable growth models However, in reality, the multiple-period model or the model based on infinite horizon, needs less assumptions and is thus more appropriate. Therefore, if we can obtain more detailed information and derive the theoretical model from share valuation models with infinite horizon, the results might be more convincing.

Secondly, due to the assumption of the stable growth model, we limit our sample to firms with positive earnings and cash flows over five years or more, which weakens our sample to some extent. More importantly, these requirements restrict our sample by excluding the lossing-firms. Therefore, this result might only pertain to profitable firms.

Thirdly, due to data availability, trade-weighted exchange rate is employed in this thesis, in order to represent firms' competing environments and trade patterns.

However, firm-specific exchange rates are more accurate for modeling currency exposure.

Finally, the argument suffers from some econometric shortcomings. For example, research has suggested that the VAR estimation of stock returns is sensitive to the state variables included.

Although there are some limitations here, this thesis makes the first existing attempt to depict exchange rate transmission channels, and this provides an original analysis of the interaction between exchange rates and stock prices at micro level. The shortcomings of this study can be addressed in future research.

6.5 Promising ideas for future research

From the findings presented in this thesis, a number of promising research ideas can be introduced. These ideas can be summarized as follows.

Firstly, there is a difference between predicted and actual overall stock price sensitivity; therefore, the possible explanations for this difference will need to be studied in the future. Secondly, research suggests that variations in exchange rate will have a different impact on importing, exporting and domestic firms. Hence, more detailed evidence can be obtained if we can distinguish between these types of firm. In addition, hedging activities are usually related to foreign exchange rate issues. Thus, future research can also investigate the effect of various hedging activities on transmission channels. To name but a few potential further questions: are there some transmission channels which can never be hedged? Which channel is most affected by hedging activities?

We can clearly see that a great deal of research is still required. With a growing future investigation of the interaction between exchange rates and stock prices, theoretically and empirically, our knowledge will be continuously enhanced.

Reference:

Abdalla, I. S. A. & Murinde, V. (1997) Exchange rate and stock price interactions in emerging financial markets: evidence on India, Korea, Pakistan and the Philippines, *Applied Financial Economics*, 7, pp25-35.

Adler, M. & Dumas, B. (1984) Exposure to currency risk: definition and measurement, *Financial Management*, pp41-50.

Aggarwal, R. (1981) Exchange rates and stock prices: A study of the US capital markets under floating exchange rates, *Akron Business and Economic Review*, 12(4), pp7--12.

Aggarwal, S. & Ramaswami, S. N. (1992) Choice of foreign market entry mode: impact of ownership, location and international factors, *Journal of International Business Studies*, 23 (1), pp1–27.

Aggarwal, R. & Harper, J. T. (2010) Foreign exchange exposure of ”domestic” corporations, *Journal of International Money and Finance*, 29, pp1619-1636.

Ahmed, E. & Omneya, A. (2007) Exchange rate exposure: do size and foreign operations matter, *Managerial Finance*, 33, pp741—765.

Ajayi, R. A. & Mougoue, M. (1996) On the dynamic relation between stock prices and exchange rates, *The Journal of Financial Research*, 19(2), pp193—207.

Akbar, S. & Stark, A. W. (2003) Deflators, net shareholder cash flows, dividends, capital contributions and estimated models of corporate valuation, *Journal of Business Finance & Accounting*, 30(9), pp1211-1233.

Akbar, S., Shah, S. Z. A. & Stark, A. W. (2011) The value relevance of cash flows, current accruals, and non-current accruals in the UK, *International Review of Financial Analysis*, 20(5), pp311--319.

Alagidedea, P., Panagiotidisb, T. & Zhang, X. (2011) Causal relationship between stock prices and exchange rates, *The Journal of International Trade & Economic Development*, 20(1), pp67–86.

Allayannis, G. & Ihrig, J. (2001) Exposure and mark-ups, *The Review of Financial Studies*, 14, pp805—835.

Allayannis, G. & Ofek, E. (2001) Exchange rate exposure, hedging, and the use of foreign currency derivatives, *Journal of International Money and Finance*, 20, pp273–296.

Ampomah, S. A., Mazouz, K. & Yin, S. (2012) The foreign exchange exposure of UK non-financial firms: A comparison of market-based methodologies, *International Review of Financial Analysis*, forthcoming.

Arellano, M. & Bond, S. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *The Review of Economic Studies*, 58(2), pp277--297.

Arellano, M. & Bover, O. (1995) Another look at the instrumental variable estimation of error-components models, *Journal of econometrics*, 68(1), pp29--51.

Bahmani-oskooee, M. & Sohrabian, A. (1992) Stock price and the effective exchange rate of the dollar, *Applied Economics*, 24, pp459—464.

Bailey, W. and Chung, Y. P. (1995) Exchange rate fluctuations, political risk, and stock returns: some evidence from an emerging market, *Journal of Financial and Quantitative Analysis*, 30, pp541—561.

Baginski, S. P. & Wahlen, J. M. (2003) Residual income risk, intrinsic values, and share prices, *The Accounting Review*, 78(1), pp327—351.

Bank of England (2004) The new sterling ERI, Quarterly Bulletin Winter 2004 Contents, http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb040402.pdf

Barker, R. G (1999) The role of dividends in valuation models used by analysts and fund managers, *European Accounting Review*, 8(2), pp195--218.

Barth, M. E., Beaver, W. H., Hand, J. R. & Landsman, W. R. (1999) Accruals, cash flows, and equity values, *Review of Accounting Studies*, 4(3-4), pp205--229.

Barton, J., Hansen, T. B. & Pownall, G. (2010) Which performance measures do investors around the world value the most-and why, *The Accounting Review*, 85(3), pp753--789.

Bartov, E. & Bodnar, G. M. (1994) Firm valuation, earnings expectations, and the exchange-rate exposure effect, *The Journal of Finance*, 49, pp1755--1785.

Bartram, S. M. (2007) Corporate cash flow and stock price exposures to foreign exchange rate risk, *Journal of Corporate Finance*, 13, pp981-994.

Bartram, S. M. (2008) What lies beneath: Foreign exchange rate exposure, hedging and cash flows, *Journal of Banking & Finance*, 32, pp1508-1521.

Bartram, S. M., Brown, G. W. & Fehle, F. R. (2009) International evidence on financial derivatives usage, *Financial Management*, 38(1), pp185-206.

Bartram, S. M., Brown, G. W. & Minton, B. A. (2010) Resolving the exposure puzzle: The many facets of exchange rate exposure, *Journal of Financial Economics*, 95, pp148-173.

Bartram, S. M. & Bodnar, G. M. (2007) The exchange rate exposure puzzle, *Managerial Finance*, 33, pp642-666.

Bartram, S. M. & Bodnar, G. M. (2012) Crossing the lines: The conditional relation between exchange rate exposure and stock returns in emerging and developed markets, *Journal of International Money and Finance*, 31, pp766–792.

Baum, C. F., Schaffer, M. E. & Stillman, S. (2007) Enhanced routines for instrumental variables/GMM estimation and testing, *The Stata Journal*, 7(4), pp465--506.

Benartzi, S., Michaely, R. & Thaler, R. (1997) Do Changes in Dividends Signal the

Future or the Past, *The Journal of Finance*, 48, pp1007—1034.

Berkman, H., Bradbury, M. E. & Magan, S. (1997) An International Comparison of Derivatives Use, *Financial Management*, 26(4), pp69–73.

Bodnar, G. M., Dumas, B. & Marston, R. C. (2002) Pass - through and Exposure, *The Journal of Finance*, 57(1), pp199--231.

Bodnar, G.M. & Gentry, W. M. (1993) Exchange rate exposure and industry characteristics: evidence from Canada, Japan, and the USA, *Journal of International Money and Finance*, 12, pp29—45.

Bodnar, G.M., Hayt, G.S. & Marston R.C. (1995) Wharton survey of derivatives usage by US non-financial firms, *Financial Management*, 24 (2), pp104–114.

Bodnar, G. M., Hayt, G. S. & Marston, R. C. (1996) 1995 Wharton survey of derivatives usage by US non-financial firms, *Financial Management*, 25, pp113—133.

Bodnar, G.M., Hayt, G.S. & Marston R.C. (1998) Wharton survey of financial risk management by US non-financial firms, *Financial Management*, 27 (4) (1998), pp70--91.

Bodnar, G.M. & Wong, M.H. (2003) Estimating exchange rate exposures: Issues in model structure, *Financial Management*, 32, pp35–67.

Botshekan, M.,Kraeussl, R. & Lucas, A. (2012) Cash Flow and Discount Rate Risk in Up and Down Markets: What Is Actually Priced, *Journal of Financial and Quantitative Analysis*, 47(6), pp 1279-1301

Branson, W.H. (1983) Macroeconomic determinants of real exchange rate risk, In Managing foreign exchange rate risk, ed. R.J. Herring. Cambridge, MA: Cambridge University Press.

Bredin, D. & Hyde, S. (2011) Investigating sources of unanticipated exposure in industry stock returns, *Journal of Banking & Finance*, 35, pp1128-1142.

Brief, R. & Zarowin, P. (1999) The value relevance of dividends, book value and earnings, New York University Dept. of Accounting Working Paper, (99-3).

Brooks, R. D., Iorio, A. D., Faff, R. W., Fry, T. & Joymungul, Y. (2010) Asymmetry and time variation in exchange rate exposure: An investigation of Australian stocks returns, *International Journal of Commerce and Management*, 20, pp276--295

Callen, J. L. & Segal, D. (2004) Do Accruals Drive Firm‐Level Stock Returns? A Variance Decomposition Analysis, *Journal of Accounting Research*, 42(3), pp527--560.

Campa, J. M. & Goldberg, L. S. (2001) Employment versus wage adjustment and the US dollar, *Review of Economics and Statistics*, 83(3), pp477--489.

Campbell, J. Y. (1991) A variance decomposition for stock returns (No. w3246), National Bureau of Economic Research.

Campbell, J. Y. & Ammer, J. (1993) What moves the stock and bond markets? A variance decomposition for long-term asset returns, *The Journal of Finance*, 48, pp3-37.

Campbell, J. Y. & Mei, J. (1993) Where do betas come from? Asset price dynamics and the sources of systematic risk, *Review of Financial Studies*, 6(3), pp567-592.

Campbell, J. Y. & Shiller, R. J. (1988) The dividend-price ratio and expectations of future dividends and discount factors, *Review of Financial Studies*, 1, pp195-228.

Campbell, J. Y. & Vuolteenaho, T. (2004) Bad Beta, Good Beta, *American Economic Review*, 94, pp1249–-1275.

Campbell, J. Y., Polk, C. & Vuolteenaho, T. (2010) Growth or glamour? Fundamentals and systematic risk in stock returns, *Review of Financial Studies*, 23(1), pp305--344.

Carrieri, F., Errunza, V. & Majerbi, B. (2006) Does emerging market exchange risk affect global equity prices, *Journal of Financial & Quantitative Analysis*, 41, pp511-540.

Chaieb, I. & Mazzotta, S. (2013) Unconditional and conditional exchange rate exposure, *Journal of International Money and Finance*, 32, pp781—808.

Charitou, A. & Clubb, C. (1999) Earnings, cash flows and security returns over long return intervals: Analysis and UK evidence, *Journal of business finance & accounting*, 26, pp283--312.

Chan, L. K., Karceski, J. & Lakonishok, J. (2003) The level and persistence of growth rates, *The Journal of Finance*, 58(2), 643-684.

Chen, L. (2010) On return and beta decompositions: governing principles and applications, Available at SSRN 1594355.

Chen, S. & Chen, T. (2012) Untangling the non-linear causal nexus between exchange rates and stock prices: New evidence from the OECD countries, *Journal of Economic Studies*, 39, pp231--259

Chen, L., Da, Z. & Priestley, R. (2012) Dividend smoothing and predictability, *Management Science*, 58(10), pp1834--1853.

Chen, L., Da Z. & Zhao, X. (2013) What Drives Stock Price Movements, *The Review of Financial Studies*, 26(4), pp841-876.

Chen, H., Kacperczyk, M., Molina, H. O. (2011) Labour unions, operating flexibility, and cost of equity, *Journal of Financial & Quantitative Analysis*, 46(1), pp25-58.

Chen, L. & Zhao, X. (2009) Return decomposition, Review of Financial Studies, 22(12), pp5213-5249.

Choi, J. J., Hiraki, T. And Takezawa, N. (1998) Is foreign exchange risk priced in the Japanese Stock Market, *Journal of Financial & Quantitative Analysis*, 33, pp361-382.

Choi, J. J. & Jiang, C. (2009) Does multinationality matter? Implications of operational hedging for the exchange risk exposure, *Journal of Banking & Finance*, 33, pp1973–1982.

Choi, J. J. & Prasad, A. M. (1995) Exchange rate sensitivity and its determinants: A firm and industry analysis of U. S. multinationals, *Financial Management*, 24(3), pp77-88.

Chow, E. H., Lee, W. Y. & Solt, M. E. (1997) The economic exposure of US multinational firms, *The Journal of Financial Research*, 20, pp191—210.

Chue, T. K. & Cook, D. (2008) Emerging market exchange rate exposure, *Journal of Banking and Finance*, 32, pp1349-1362.

Claus, J., & Thomas, J. (2001) Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets, *The Journal of Finance*, 56(5), pp1629-1666.

Cochrane, J. H. (2008) The dog that did not bark: A defence of return predictability, *Review of Financial Studies*, 21(4), pp1533-1575.

Cochrane, J. H. (2011) Presidential address: Discount rates, *The Journal of Finance*, 66(4), pp1047--1108.

Corsetti, G. & Dedola, L. (2005) A macroeconomic model of international price discrimination, *Journal of International Economics*, *67*(1), pp129--155.

Courteau, L., Kao, J. L., & Richardson, G. D. (2001) Equity valuation employing the ideal versus Ad Hoc terminal value expressions, *Contemporary accounting research*, 18(4), pp625--661.

Da, Z. (2009) Cash flow, consumption risk, and the cross-section of stock returns, *The Journal of Finance*, 64(2), pp923-957.

Da, Z. and Warachka, M. C. (2009) Cash flow risk, systematic earnings revisions, and the cross-section of stock returns, *Journal of Financial Economics*, 94, pp448-468.

Damodaran, A (2005) Valuation approaches and metrics: A survey of the theory and evidence, *Foundations and Trends in Financ*e, 1(8), pp693--784.

De Santis, G. & Gerard, B. (1998) How big is the premium for currency risk, *Journal of Financial Economics*, 48, pp375–412.

Dekle, R. (2005) Exchange Rate Exposure and Foreign Market Competition: Evidence from Japanese Firms, *The Journal of Business*, 78, pp281--300.

Demirakos, E. G., Strong, N. C. & Walker, M. (2004) What valuation models do analysts use, *Accounting Horizons*, 18(4), pp221--240.

Demirakos, E. G., Strong, N. C. & Walker, M. (2010) Does valuation model choice affect target price accuracy, *European Accounting Review*, 19(1), pp35--72.

Doidge, C., Griffin, J. & Williamson, R. (2006) Measuring the economic importance of exchange rate exposure, *Journal of Empirical Finance*, 13, pp550--576.

Dominguez, K. M. E., & Tesar, L. L. (2001) Trade and exposure, *American Economic Review*, 91(2), pp367–370.

Dominguez, K.M.E., & Tesar, L. L. (2006) Exchange rate exposure, *Journal of International Economics*, 68 (1), pp188–218.

Doong, S., Yang, S. & Wang, A. T. (2005) The dynamic relationship and pricing of stocks and exchange rates: empirical evidence from Asian emerging markets, *Journal of American Academy of Business*, 7, pp118—123.

Dornbusch, R. & Fisher, S. (1980) Exchange rates and the current account, *American Economic Review*, 70, pp960--971.

Doukas, J. Hall, P. H. & Lang, L. H. (1999) The pricing of currency risk in Japan, *Journal of Banking & Finance*, 23, pp1--20.

Dumas, B. & Solnik, B. (1995) The World Price of Foreign Exchange Risk, *The Journal of Finance*, 50, pp445-479.

Easton, P. D. (2004) PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital, *The Accounting Review*, 79(1), pp73-95.

Easton, P. D. & Monahan, S. J. (2005) An evaluation of accounting-based measures of expected returns, *The Accounting Review*, 80, pp501—538.

Ehrmann, M., Fratzscher, M. & Rigobon, R. (2011) Stocks, bonds, money markets and exchange rates: measuring international financial transmission, *Journal of Applied Econometrics*, 26, pp948—974.

Engsted, T., Pedersen, T. Q. & Tanggaard, C. (2012) Pitfalls in VAR based return decompositions: A clarification, *Journal of Banking & Finance*, 36(5), pp1255-1265.

Fama, E. F. & French, K. R. (1992) The cross-section of expected stock returns, *The Journal of Finance*, 47, pp427-465.

Fama, E. F. & French, K. R. (2006) The Value Premium and the CAPM, *The Journal of Finance*, 61, pp2163-2185.

Fama, E. F. & French, K. R. (2008) Average returns, B/M, and share issues, *The Journal of Finance*, *63*(6), pp2971--2995.

Fang, W. & Miller, S.M. (2002) Currency depreciation and Korean stock market performance during the Asian financial crisis. Working Paper 2002–30, University of Connecticut

Francis, J., Olsson, P. & Oswald, D. R. (2000) Comparing the accuracy and explainability of dividend, free cash flow, and abnormal earnings equity value estimates, *Journal of Accounting Research*, 38, pp45—70.

Francis, B. B., Hasan, I. & Hunter, D. M. (2008) Can hedging tell the full story? Reconciling differences in United States aggregate—and industry-level exchange rate risk premium, *Journal of Financial Economics*, 90, pp169-196.

Frankel, R. & Lee, C. M. C. (1998) Accounting valuation, market expectation, and cross-sectional stock returns, *Journal of Accounting and Economics*, 25, pp283—319.

Friberg, R. & Ganslandt, M. (2007) Exchange rates and cash flows in differentiated product industries: A simulation approach, *The Journal of Finance*, 62, pp2475—2502.

Gao, T. (2000) Exchange rate movements and the profitability of U.S. multinationals, *Journal of International Money and Finance*, 19, pp117—134.

Garrett, I. & Priestley, R. (2012) Dividend Growth, Cash Flow, and Discount Rate News, *Journal of Financial and Quantitative Analysis*, 47(05), pp1003--1028.

Gavin, M. (1989) The stock market and exchange rate dynamics, *Journal of International Money and Finance*, 8, pp181—200.

Gebhardt, W. R., Lee, C. & Swaminathan, B. (2001) Toward an implied cost of capital, *Journal of Accounting Research*, 39(1), pp135--176.

Granger, C. W. J., Huang, B. N. & Yang, C. W. (2000) A bivariate causality between stock prices and exchange rates: evidence from recent Asian flu, *The Quarterly Review of Economics and Finance*, 40, pp337–354.

Goldberg, L. S. & Campa, J. M. (2010) The sensitivity of the CPI to exchange rates: distribution margins, imported inputs, and trade exposure, *The Review of Economics and Statistics*, 92(2), pp169-196.

Habib, A. (2008) The role of accruals and cash flows in explaining security returns: evidence from New Zealand, *Journal of international accounting, auditing and taxation*, 17(1), pp51--66.

Hagelin, N. & Pramborg, B. (2006) Empirical evidence concerning incentives to hedge transaction and translation exposures, *Journal of Multinational Financial Management*, 16, pp142–159.

Hatemi-J, A. & Irandoust, M. (2005) On the causality between exchange rates and stock prices: a note, *Bulletin of Economic Research*, 54(2), pp197—203.

Hau, H. & Rey, H. (2006) Exchange Rates, Equity Prices, and Capital Flows, *The Review of Financial Studies*, 19(1), pp273—317.

Haugen, R. A. & Baker, N. L. (1996) Commonality in the determinants of expected stock returns, *Journal of Financial Economics*, 41, pp401-439.

He, J., & Ng, L. K. (1998) The foreign exchange exposure of Japanese multinational corporations, *The Journal of Finance*, 53(2), pp733–753.

Hecht, P., & Vuolteenaho, T. (2006) Explaining returns with cash-flow proxies, *Review of Financial Studies*, 19(1), pp159--194.

Huffman, S. P., Makar, S. D. & Beyer, S. B. (2010) A three-factor model investigation of foreign exchange-rate exposure, *Global Finance Journal*, 21, pp1-12.

Hutson, E. & O'Driscoll, A (2010) Firm-level exchange rate exposure in the Euro zone, *International Business Review*, 19, pp468-478.

Hutson, E. & Stevenson, S. (2010) Openness, hedging incentives and foreign exchange exposure: A firm-level multi-county study, *Journal of International Business Studies*, 41, pp105-122.

Imam, S., Barker, R. & Clubb, C. (2008) The use of valuation models by UK investment analysts, *European accounting review*, 17(3), pp503--535.

Imam, S., Chan, J. & Shah, S. (2013) Equity valuation models and target price accuracy in Europe: Evidence from equity reports, *International Review of Financial Analysis*, 28, pp9—19.

Inci, A. C. & Lee, B. (2014) Dynamic relations between stock returns and exchange rate changes, *European Financial Management*, 20, pp71-106.

Iorio, A. D. & Faff, R. (2001) A test of the stability of exchange rate risk: Evidence from the Australian equities market, *Global Finance Journal*, 12, pp179--203.

Jiang, X. & Lee, B. (2005) An empirical test of the accounting-based residual income model and the traditional dividend discount model, *The Journal of Business*, 78, pp1465—1504.

Jiang, X. & Lee, B. S. (2007) Stock returns, dividend yield, and book-to-market ratio, *Journal of Banking & Finance*, 31(2), pp455--475.

Jiang, W., & Stark, A. W. (2012) Dividends, accounting information, and the valuation of loss-making firms in the UK. , *British Accounting Review*, Forthcoming

Jorion, P. (1990) The exchange-rate exposure of US multinationals, *Journal of Business*, pp331--345.

Jorion, P. (1991) The pricing of exchange rate risk in the stock market, *Journal of Financial and Quantitative Analysis*, 26, pp363—376.

Jong, A. D., Ligterink, J. & Macrae, V. (2006) A firm-specific analysis of the exchange-rate exposure of Dutch firms, *Journal of International Financial Management and Accounting*, 17, pp1—28.

Jongen, R., Muller, A. & Verschoor, W.F.C. (2012) Using survey data to resolve the exchange risk exposure puzzle: Evidence from U.S. multinational firms, *Journal of International Money and Finance*, 31, pp148—169.

Judge, A. (2006) Why and how UK firms hedge, *European Financial Management*, 12(3), pp407-441.

Kahle, K. M. & Walkling, R. A. (1996) The Impact of Industry Classifications on Financial Research, *Journal of Financial and Quantitative Analysis*, 31, pp309–335.

Katechos, G. (2011) On the relationship between exchange rates and equity returns: A new approach, *Journal of International Financial Markets, Institutions & Money*, 21, pp550--559

Kelly, B. & Pruitt, S. (2013) Market Expectations in the Cross-Section of Present Values, *The Journal of Finance*, forthcoming.

Khoo, A. (1994) Estimation of foreign exchange exposure: an application to mining companies in Australia, *Journal of International Money and Finance*, 13, pp342—363.

Kim, K (2003) Dollar exchange rate and stock price: evidence from multivariate cointegration and error correction model, *Review of Financial Economics*, 12, pp301-313.

Kiymaz, H. (2003) Estimation of foreign exchange exposure: an emerging market application, *Journal of Multinational Financial Management*, 13, pp71--84

Kohler, M. (2010) Exchange rates during financial crises, *BIS Quarterly Review*, March 2010.

Kolari, J. W. Moorman T. C. & Sorescu, S. M. (2008) Foreign exchange risk and the cross-section of stock returns, *Journal of International Money & Finance, 27,* pp1074-1097.

Koutmos , G. & Martin, A. D. (2003) Asymmetric exchange rate exposure: theory and evidence, *Journal of International Money and Finance*, 22, pp365--383.

Larrain, B. & Yogo, M. (2008) Does firm value move too much to be justified by subsequent changes in cash flow, *Journal of Financial Economics*, 87(1), pp200--226.

Lee, C., Ng, D. & Swaminathan, B. (2009) Testing international asset pricing models using implied costs of capital, *Journal of Financial and Quantitative analysis*, 44(2), pp307-335.

Lee, B. & Suh, J. (2012) Exchange rate changes and the operating performance of multinationals, *European Financial Management*, 18, pp88--116.

Lewellen, J. & Nagel, S. (2006) The conditional CAPM does not explain asset-pricing anomalies, *Journal of Financial Economics*, 82, pp289–314.

Lin, C. (2012) The comovement between exchange rates and stock prices in the Asian emerging markets, *International Review of Economics and Finance*, 22, pp161—172.

Liu, J., Nissim, D. & Thomas, J. (2007) Is cash flow king in valuations, *Financial Analysts Journal*, pp56--68.

Loudon, G. (1993) The foreign exchange operating exposure of Australian stocks, *Accounting and Finance*, 33, pp19—32.

Lundholm, R. J. & O'Keefe, T. B. (2001a) Reconciling value estimates from the discounted cash flow model and the residual income model, *Contemporary Accounting Research*, 18(2), pp311--335.

Lundholm, R. J. & O'Keefe, T. B. (2001b) On Comparing Residual Income and Discounted Cash Flow Models of Equity Valuation: A Response to Penman 2001 (CAR, Winter 2001)*, *Contemporary Accounting Research*, 18(4), pp693--696.

McMillan, D. G., & Wohar, M. E. (2010) Stock return predictability and dividend‐price ratio: a nonlinear approach, *International Journal of Finance & Economics*, 15(4), pp351--365.

Minton, B. A. & Schrand, C. (1999) The impact of cash flow volatility on discretionary investment and the costs of debt and equity financing, *Journal of Financial Economics*, 54(3), pp423–460.

Mishra, A. K. (2005) Stock market and foreign exchange market in India: are they related, *South Asia Economic Journal*, 5(2), pp209—232.

Morningstar (2011) Morningstar equity research methodology, Morningstar Research Report,

http://news.morningstar.com/pdfs/Equity_Research_Methodology_102308.pdf

Muller, A. & Verschoor, W. F. C. (2006a) Asymmetric foreign exchange risk exposure: Evidence from U.S. multinational firms, *Journal of Empirical Finance*, 13, pp495--518.

Muller, A. & Verschoor, W. F. C. (2006b) European foreign exchange risk exposure, *European Financial Management*, 12, pp195--220.

Muller, A. & Verchoor, W. F. C. (2009) The effect of exchange rate variability on US shareholder wealth, *Journal of Banking & Finance,* 33, pp1963-1972.

Mun, K. (2012) The joint response of stock and foreign exchange markets to macroeconomic surprises: Using US and Japanese data, *Journal of Banking & Finance*, 36, pp383—394.

Murinde, V. & Poshakwale, S. (2004) Exchange rate and stock price interaction in the European emerging financial markets before and after Euro, unpublished paper presented at the 2004 EFMA Annual Meeting, Basel, Switzerland.

Nance, D.R., Smith, C. & Smithson, C. (1993) On the determinants of corporate hedging, *The Journal of Finance*, 48 (1), pp267–284.

Nieh, C. & Lee, C. (2001) Dynamic relationship between stock prices and exchange rates for G-7 countries, *The Quarterly Review of Economics and Finance*, 41, pp477–490.

Nucci, F. & Pozzolo, A. F. (2010) The exchange rate, employment and hours: what firm-level data say, *Journal of International Economics*, 82, pp112-123.

Ohlson, J. A. (1990) A synthesis of security valuation theory and the role of dividends, cash flows, and earnings, *Contemporary Accounting Research*, 6, pp648—676.

Ohlson, J. A. (2001) Earnings, book values, and dividends in equity valuation: an empirical perspective, *Contemporary Accounting Research*, 18, pp107—120.

Ohlson, J. A. & Juettner-Nauroth, B. E. (2005) Expected EPS and EPS Growth as Determinants of Value, *Review of Accounting Studies*, 10, pp349--365.

Pan, M. S., Fok, R. C. & Liu, Y. A. (2007) Dynamic linkages between exchange rates and stock prices: Evidence from East Asian markets, *International Review of Economics and Finance*, 16, pp503—520.

Pan, M. S. & Liu, Y. A. (2012) Exchange rate exposure: evidence from industry-specific exchange rates, *International Research Journal of Finance and Economics*, 84, pp121—132.

Pantzalis, C., Simkins, B. J., & Laux, P. A. (2001) Operational hedges and the foreign exchange exposure of US multinational corporations, *Journal of International Business Studies*, 32(4), pp793–812.

Patra, T. & Poshakwale, S. (2006) Economic variables and stock market returns: evidence from the Athens stock exchange, *Applied Financial Economics*, 16, pp993–1005.

Parsley, D. C. & Popper, H. A. (2006) Exchange rate pegs and foreign exchange exposure in East and South East Asia, *Journal of International Money and Finance*, 25, pp992--1009.

Penman, S. H. (2010) Financial forecasting, risk and valuation: Accounting for the future, *Abacus*, *46*(2), pp211--228.

Peman, S. H. & Sougiannis, T. (1998) A comparison of dividend, cash Flow, and earnings approaches to equity valuation, *Contemporary Accounting Research*, 15, pp343—383.

Penman, S. H. (2001) On Comparing Cash Flow and Accrual Accounting Models for Use in Equity Valuation: A Response to Lundholm and O'Keefe (CAR, Summer 2001), *Contemporary Accounting Research*, 18(4), pp681--692.

Petersen, M.A. & Thiagarajan, S.R. (2000) Risk measurement and hedging: with and without derivatives, *Financial Management*, 29 (4), pp5–30.

Phylaktis, K. & Ravazzolo, F. (2005) Stock prices and exchange rate dynamics, *Journal of International Money and Finance*, 24, pp1031--1053.

Prasad, A. M. & Rajan, M. (1995) The role of exchange and interest risk in equity valuation: a comparative study of international stock markets, *Journal of Economics and Business*, 47, pp457—472.

Priestley, R. & Ødegaard, B. A. (2007) Linear and nonlinear exchange rate exposure, *Journal of International Money and Finance*, 26, pp1016—1037.

Ratanapakorn, O. & Sharma, S. C. (2007) Dynamic analysis between the US stock returns and the macroeconomic variables, *Applied Financial Economics*, 17, pp369–377.

Rees, W. P. (1997) The impact of dividends, debt and investment on valuation models, *Journal of Business Finance & Accounting*, 24, pp1111-1140.

Rees, W. & Unni, S. (2005) Exchange rate exposure among European firms: evidence from France, Germany and the UK, *Accounting and Finance*, 45, pp479—497.

Roberts, M. R. & Whited, T. M. (forthcoming) Endogeneity in empirical corporate finance. In: Constantinides, M., Stulz, R. (Eds.) Handbook of the Economics of Finance, vol.2. Elsevier.

Shimko, D. (1997) Yearnings per share, *Risk*, 10, pp37.

Sims, C. (1980) Macroeconomics and Reality, *Econometrica*, 48, pp1–48.

Soenen, L. A. & Hennigar, E. S. (1988) An analysis of exchange rates and stock prices--the U.S. experiences between 1980 and 1986, *Akron Business and Economic Review*, 19(4), pp7—16.

Smith, C. E. (1992a) Equities and the UK exchange rate, *Applied Economics*, 24, pp327—335.

Smith, C. E. (1992b) Stock markets and the exchange rate: a multi-country approach, *Journal of Macroeconomics*, 14(4), pp697—629.

Smyth, R. & Nandha, M. (2003) Bivariate causality between exchange rates and stock prices in South Asia, *Applied Economics Letters*, 10, pp699–704.

Solnik, B. (1987) Using financial prices to test exchange rate models: a note, *The Journal of Finance,* 42, pp141—149.

Stark, A. W. & Thomas, H. M. (1998) On the empirical relationship between market value and residual income in the UK, *Management Accounting Research*, 9(4), pp445--460.

Stavarek, D. (2005) Stock prices and exchange rates in the EU and the USA: Evidence on their mutual interactions, *Czech Journal of Economics and Finance*, 55, pp141--161.

Subramanyam, K. R., & Venkatachalam, M. (2007) Earnings, cash flows, and ex post intrinsic value of equity, *The Accounting Review*, 82(2), pp457--481.

Tai, C. (2007) Asymmetric currency exposure and currency risk pricing, *International Review of Financial Analysis*, 17, pp647--663.

Tai, C. (2010) Foreign exchange risk and risk exposure in the Japanese stock market, *Managerial Finance*, 36, pp511—524.

Tsagkanos, A. & Siriopoulos, C. (2013) A long-run relationship between stock price index and exchange rate: A structural nonparametric cointegrating regression approach, *Journal of International Financial Markets, Institutions & Money*, 25, pp106–118.

Vassalou, M. (2000) Exchange rate and foreign inflation risk premiums in global equity returns, *Journal of International Money and Finance*, 19, pp433—470.

Vuolteenaho, T. (2002) What Drives Firm‐Level Stock Returns, *The Journal of Finance*, 57(1), pp233--264.

Williamson, R. (2001) Exchange rate exposure and competition: evidence from the automotive industry, *Journal of Financial Economics*, 59, pp441--475.

Wongbangpo, P. & Sharma, S. C. (2002) Stock market and macroeconomic fundamental dynamic interactions: ASEAN5 countries, *Journal of Asian Economics*, 13, pp27—51.

Yang, S. & Doong, S. (2004) Price and volatility spillovers between stock prices and exchange rates: empirical evidence from the G-7 countries, *International Journal of Business and Economics*, 3(2), pp139—153.

Yau, H. & Nieh, C. (2006) Interrelationships among stock prices of Taiwan and Japan and NTD/Yen exchange rate, *Journal of Asian Economics*, 17, pp535–552.