ESSAYS ON CONFLICT

by

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Abstract

War has been one of the most destructive forms of interactive behaviour in the world. There has been a vast body of work that try to make better understanding of the nature of war and its causes. The various types of inter- and intra-country conflict have received increasing attention by economists in the past few decades. The aim of this thesis is attempting to contribute to the study of conflict. Using a game-theoretic framework, we study the economic causes of inter- and intra-state conflict, and analyse the relationship between political regime and war. Our study reveals the possible mechanisms of conflict escalation by applying bargaining theory, and thus provides a new perspective for understanding the "democratic peace" hypothesis and the feasibility theory as important explanation for the onset of war.

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TO MY LOVING PARENTS

致我的父母

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Introduction

Conflict and war have always existed as one of the persistent patterns of interaction among and within states or even other political units over the years. As the most destructive form of interactive behaviour, war consumes great amounts of resources, both natural and human, and destroys environments and cultures. Its profound impact on both the redistribution of military power and wealth, and the structure of the economy globally, has made it one of the primary mechanisms for change in the world economy (Levy and Thompson, 2011). Without doubt, war affects human life, not just for those who are involved but also for those who are not, which has led to a vast body of work analysing the causes and consequences of war. Why do wars occur, and especially what kinds of factors influence the escalation of conflicts between rational actors? There are many aspects of this question to consider before arriving at an answer. In this thesis we fill in several gaps within the study of conflict. In particular, we not only focus on the economic causes of inter-state conflict, but also provide some insight into the understanding of the "democratic peace" hypothesis and civil war.

Bargaining theory has been commonly used to explain international relations. Formal studies of conflicts generally see the conduct of war as a bargaining process. The "bargain-

ing model of war" is then developed as the application of non-cooperative game theory. This focuses on the setting in which the negotiations take place, and on characterizing the bargaining strategies and final outcomes at equilibrium. Our study is based on a bargaining theory, and follows a typical decision-making approach. The rational decision-making process involves the selection of strategies and the maximization of values under constraints.

In chapter 1, we look at the economic causes of inter-state conflict escalation. The desire for gain has often played an essential role in the generation of conflict. We attempt to provide an analytical and systematic explanation for the operation of the economic motive in war. The notion of non-transferable benefits is introduced to reveal the possible mechanism of conflict escalation without information asymmetry. We also conduct empirical work to verify the following theoretical finding: there exists a non-monotonic relationship between the relative wealth of two states on the probability of conflict escalation between them.

There is a long history of the belief that democracy promotes peace. Empirical evidence is found to support that democracies do not fight wars with one another, which is widely recognized as "democratic peace" hypothesis. While this is true at the dyadic level of analysis, no clear relationship between democracy and peace is found at the national level. In other words, democracies do not more frequently maintain peace overall. To further study the relationship between democracy and peace, chapter 2 extends the basic bargaining model by introducing political regime type and asymmetric information. Our results confirm the idea that political incentives drive a leader to use his discretionary powers when facing a risk of war, in order to secure re-election. Hence, we argue that a

better explanation of democratic peace is provided by the interaction of economic structure with political regime rather than the political feature of the type of regime alone.

Civil war has become far more common than international conflict in recent years. While there are a great number of studies in the realm of political science, economics can also offer analytical insights, especially where game theory provides an ideal tool for conflict analysis. Chapter 3 discusses the problems that prevent the reaching of a settlement in the bargaining between a central government and potential rebel groups. In this chapter, we focus on the distinctive feature of civil war: the emergence and persistence of a rebel army, including how armed groups and coalitions form and cohere, and the issues of credible commitment and maintaining post-settlement peace.

Chapter 1

Bargaining over War: An Economic Model

Abstract

This chapter seeks to answer the questions on how economic motives could lead to inter-state war and how wealth levels are related to the initiation of war. Our methodological approach involves the building of a theoretical model of bargaining in which the actions of both sides in a two-country conflict model can lead to either a pre-war negotiated settlement or war and testing the model empirically. A notion of non-transferable benefits is introduced to reveal agents' different preferences on their owned possessions, which provides us one of the possible explanations for why we observe war in reality even under perfect information. We also use datasets on militarized inter-state disputes and states' wealth to test our theoretical model and uncover evidence of a non-monotonic relationship between relative wealth of two countries on the probability of conflict escalation. This suggests a rich country is only less war-prone when it is facing an extremely poor or extremely strong target.

Key Words: Conflict, Bargaining, Wealth

1.1 Introduction

Scholars from different disciplines have provided a proliferation of theories about the motives that could drive war. In all these explanations, the desire for resources, territory, power and so forth have always played an essential part when explaining wars during the last century. As Ludwig von Mises (2004) pointed out:"The wars of the twentieth century have been, to be sure, economic wars".

Although the view that war may be caused by economic factors is not new, it seems very little effort has been made in explaining exactly how economic motives could lead to war and how important these factors could be in war initiation. This chapter intends to answer these questions. There are many other reasons that can trigger the eventuality of a war, such as religion, hatred, revenge and so forth. However, the economic cause has become more and more common in modern warfare. As pointed out by Levy and Thompson (2011) at the beginning of their book, the key variables of levels of economic and social welfare, which are critical in much of the literature on civil war, are given much less attention by scholars who study inter-state war. Therefore, we believe, to further explore the reasons for war, a careful study of economic causes is necessary.

From an economic perspective, it is widely accepted that there are two main elements that should be considered prior to initiation of war by rational actors - gains and costs. Therefore, the precondition for the occurrence of war should be that at least one side rationally believes that the expected gains from war exceed its costs. Recent research tends

to suggest that war is not an alternative to negotiation, but an extension of it. The theory is that war should be viewed as part of a dynamic bargaining process, for a limited war to happen in equilibrium, and a commitment to a negotiated settlement would appear after a period of war (Leventoğlu and Slantchev, 2007; Sánchez-Pagés, 2009; Yared, 2010).

A useful framework for the analysis of war and foreign policy behaviour is the "levels-of-analysis" framework. It is usually used to classify the different causal factors influencing the policies and actions of states and other actors. Since war is a dyadic or system-level outcome resulting from the joint actions of two or more states, to understand the causes of war an explanation of the strategic interaction of the two or more adversaries is necessary. For this reason, individual, societal, and state-level causal factors cannot, by themselves, provide a logically complete explanation for the outbreak of war. That is, they are not jointly sufficient for war. Therefore, dyadic or system-level causal variables (a theory of bargaining) need to be included for a complete explanation. This chapter aims to explore the motivation for war from an economic perspective. It is based on a two-country conflict bargaining model where there exit choices between a pre-war negotiated settlement and going to war. Additionally, it introduces non-transferable benefits which assume different preferences on possessions owned by a targeted state between two sides. By allowing the non-transferable feature of possessions for the targeted side, we are able to explain the economic implications behind wars.

War is the product of interactions among two or more states or other political organizations. While these actors are assumed to be rational, we also assume people within

a country value their land over and above its economic (or market) value - this is the non-transferable part of the benefits that do not transfer to the aggressor country should they win a war. This can lead to war even under conditions of perfect information with rational expected utility maximisers.

The structure of this chapter is as follow. Section 1.2 will review the literatures on revealing possible causes of war. Section 1.3 is the main body of the whole chapter. It begins with the basic model showing how bargaining works and then it is extended by incorporating non-transferable benefits. In the basic model, conflict between two countries is modelled as a contest in which each state acts according to their own interests. The analysis indicates that within the setting of the basic model, war should never occur.

An extension of the basic model, with non-transferable profits, shows one of the possible explanations for why we observe war in reality. The further discussion finds a non-monotonic effect of relative wealth level (wealth of targeted country/ wealth of aggressive country) on the probability of war initiation. The increase of relative wealth level first increases the incentive for attacking on the part of the aggressor since it will be able extract more wealth in case of victory. However, it then decreases the probability for the occurrence of war because the aggressive country has a smaller chance to win if a war is started. In section 1.4, we test the conclusion drawn from previous analysis and conduct an empirical analysis to support the finding. Finally, section 1.5 summarizes all sections.

1.2 Literature Review

1.2.1 Overview

War is a primitive human institution (von Mises, 2004). Mises believes the human instinct to fight is not what leads to war, because man has the power of reasoning and thinking. However, the continuous warfare happening all over the world draws people's attention to consider the causes of war. There was a time when some philosophers and economists held the idea that individual citizens do not derive any profit from the conquest of a territory or war. They concluded that under a system with economic freedom and complete political democracy there would be no wars. Although most attention was focused on democracy itself, what might have been ignored is that it is economic freedom and free trade that maintain democracy. Mises argues that citizens can actually profit from conquest, and points out that in a world of free trade and free enterprise no economic cause can trigger armed aggression. In practice, this could not be the case if most citizens believe in an improvement of their material well-being from the annexation of territory rich in resources.

Over time, scholars have realized that wars may be due to economic causes. As Robbins (1968) noted, particular wars have already been explained in terms of an economic motive; and, when the causes of war in general have come under discussion, the desire for wealth and material betterment should receive, at least, its due share of recognition. In other words, it has been clearly realized that one must take economic factors into account when discussing matters of war. Although we cannot explicitly classify wars as economic or non-economic, all wars involve economic considerations such as disposition of limited

resources, the counting of costs and so on. These factors form part of the theoretical framework to explain the occurrence of war.

Conflict is difficult to comprehend from a traditional economic perspective, as Garfinkel and Skaperdas (2007) state at the beginning of their work - an overview on the economics of conflicts. They review the recent literature on conflict and appropriation, and apply typical optimization techniques and game-theoretic tools for the economic analysis of conflict. More specifically, they model conflict as a contest game in which each side inputs its resources into arming to raise its probability of victory in case conflict does happen. According to Skaperdas (1996), contest is defined as a game in which the players compete for a prize by exerting effort so as to increase their probability of winning. It has been used in a variety of topics, especially in the study of conflicts. Following that, Garfinkel and Skaperdas explore the different forms of "contest success functions" in which the inputs of conflict are transformed into wins and losses for each side of a conflict in an adversarial way against others. These functions, also called as "technologies of conflict" by Hirshleifer (1989), are the key ingredient of conflicts, since they reveal how inputs on arming decide the winning probabilities of participants who are involved in conflict, and hence provide each player's probability of winning for any given level of effort.

An important work by Jackson and Morelli (2011) intends to provide some insights on what lead to the occurrence and recurrence of wars and how these various factors may relate to each other. They then categorise causes of war in two ways: from failure in bargaining; and from circumstances when the expected benefits from war outweigh

the costs for at least one of the sides. Jackson and Morelli also give an explanation for a common issue that is always thought to be debatable. That is that sometimes many conflicts are viewed as irrational actions. Instead of a simple pay-off maximization, they provide a broader definition of rational action - that it is relative to the agents' beliefs about the potential outcomes of their actions. This does not necessarily require these beliefs to be accurate, nor that the payoffs correspond to the expectations of the state or country the agent represents. To some extent, the payoffs may not even necessarily be material ones. The result of their broader definition is that most of conflicts that are thought to fall into the realm of irrationality can be seen as rational in nature, and thus it allows further discussion on alternative sources of conflict.

Basically, if decisions on war are made by rational policy makers through weighing gains and losses from war given their objectives, beliefs, environment and constraints, according to Fearon (1995), with mutually consistent beliefs about the potential consequences of war, rational agents should be able to reach an advantageous agreement to avoid costly war. This is because the agreement would give each adversary the same outcome it would expect to get from war without having to pay the economic and human costs of fighting. The argument that disagreement about relative power is the central cause of war has been expanded and developed into a logically consistent theory of war, which is known as the "bargaining model of war". The bargaining theory of war specifies the causal mechanism that leads from system structure to war or peace and thus provides a link between micro-motivations and macro-processes and outcomes. To answer the question: what prevents actors from reaching a negotiated settlement that spares each the costs and

risks of war, there are three mechanisms that have been discussed - the existence of either private information, a commitment problem, or indivisible issues (Fearon, 1995; Levy and Thompson, 2011).

A private information mechanism builds on Blainey's (1988) argument that disagreements about relative power, and hence about the likely outcome of war, are a central cause of war; whereas the concept of a commitment problem refers to situations in which one or more states would have an incentive to renege on the terms. The third causal mechanism that might lead to war involves indivisible issues, which arise when a proportionate division of the stakes in dispute is not possible, and hence the settlement that is mutually preferable to war becomes unattainable. Based on that, we introduce the idea of non-transferable benefits into the basic bargaining model. Similar to the indivisibility concept, the idea of non-transferable benefits represents benefits that cannot be transferred to the adversary through concessions.

1.2.2 Economic Causes of War

An essay by Humphreys (2003) reviews the relationships between economies and violent conflict. It considers economic factor that may make societies more susceptible to conflict. Humphreys argues that firstly, poverty makes civil wars more likely, and this relationship is reciprocal and stronger for very poor countries than for developing countries generally; secondly, evidence suggests that countries that trade with each other are less likely to fight each other. Hence, to prevent conflict, one should focus development efforts on the very

poor rather than on countries of intermediate wealth. The need of considering costs of conflict in order to estimate the economic value is also emphasized.

Although in this chapter we intend to investigate inter-state conflict and war, it would be worthwhile looking at the work by Collier and Hoeffler (1998) that discusses economic causes of civil wars. Despite many differences, intra- and inter-state conflicts have plenty of common features. They both consist of two or more hostile sides and are normally accompanied by military activities. Collier and Hoeffler set up a model, based on utility theory, that rebels will conduct a civil war if their expected benefits outweigh the costs of rebellion. They point out that the government's probability of victory depends on its military capability, which in turn depends upon its military expenditure. The results of their regressions show that per capita income significantly explains the duration of a civil war and the probability of its occurrence. Higher income reduces both the probability of civil war occurrence and the duration of it. However, we argue that in the case of inter-state wars the probability of victory depends on the military capabilities of both defenders and attackers.

Similarly, in another study, Chassang and Padro-i Miquel (2009) examine the relationship between income per capita and civil conflict. They develop a simple bargaining model to examine whether low opportunity costs in poor countries are able to explain two empirical patterns: that the prevalence of civil wars significantly correlates with low income per capita, and that civil war often occurs after countries suffer negative income shocks. They show that the explanation is weak for the first empirical pattern, but that it does provide

a coherent theoretical basis for the second one. Therefore, to explain the first empirical pattern, they consider another explanation concerning other structural differences that they believe are more economic in nature, for instance, the fact that in rich economies a much higher fraction of income is generated by human capital, and that this seems to be very difficult to appropriate by violent means.

The relationship between countries' wealth and inter-state conflict involvement has been paid less attention. However a paper by Maoz and Russett (1993) shows that rich countries tend to fight less with each other for they may lose more than what they can gain from war. They explain that rich states are often engaged in heavy trading with one another, which causes the costs of a war to be enormous, and so the net benefits of initiating a war would be few. Empirically, they find significant negative effects of wealth and growth rate on dyadic conflict involvement and escalation. Although in Maoz and Russett's study it has been shown that wealth level, measured by average level of income, as well as economic growth, have significant impact on conflict involvement. Yet they do not precisely interpret how these economic indices that reveal economic structure influence state conflict involvement. The simple explanation they offer "rich countries are less likely to fight with each other because they have more to lose in the war" is not necessarily true. Because if we consider the incentive for war to be the product of the probability of victory and its consequences, then both the stronger relative power of richer aggressors and the potential bigger profit from richer targets in case of winning would increase the risk of war between rich countries. Since economy size both increases the probability of victory and possible loss in the event of defeat, its net effect on war should be ambiguous.

The idea that different regime types lead to different incentives for going to war is well-demonstrated in a classic paper by Kant (2010). Over the past few decades there have been many studies which try to explore the impact of different political regimes on their conflict involvement. Some studies find empirical evidence showing that democracies rarely go to war with each other, namely the "democratic peace". Maoz and Abdolali (1989) use comprehensive datasets on polity characteristics and militarized inter-state disputes to perform empirical analysis. They conclude that in general there is no relationship between regime type and conflict involvement at an individual level, while at the dyadic level democracies rarely clash with one another. Although we are not attempting to explain the reasons for "democratic peace", we believe that including the regime characteristics of the dyads in our empirical analysis is necessary.

Baliga et al. (2011) study how domestic political concerns and the fear of being attacked can trigger aggression. By using Polity data and Correlates of War data, they confirm the result of a non-monotonic relationship between democracy and peace. In their empirical model, the Polity net democracy score is utilized to construct a set of dummy variables that characterize the regime types of each dyad in the sample. They propose the initial classification of regimes into dictatorships (net democracy scores below -3), limited democracies (scores between -3 and 3) and full democracies (scores above 3). For the period 1816-2000, their empirical estimations suggest that a dyad of limited democracies is more likely to be involved in a militarized dispute than any other dyad.

While most empirical literature supports that trade between countries creates ties binding the interests of countries and thus reduces conflict, Goenner (2011) considers the possible reciprocal relationship between trade and conflict and addresses the endogeneity caused by that. The lagged value of endogenous regressor are used as relevant and exogenous instruments, and they found that trade significantly reduces conflict, which is consistent with the liberal peace proposition.

1.3 Theoretical Analysis

In this section we develop a two- country conflict bargaining game where one country makes a proposal first, and another country can decide whether to accept this proposal or not. If the other country rejects the proposal then the first country can decide whether to start a war. We follow the bargaining framework by Filson and Werner (2004) and the basic materialistic model of war by Jackson and Morelli (2007). Their models are used to study the initiation of war, but we focus on how economic incentives play a role in the bargaining process. Intuitively, it would seem that the higher wealth level of a country can both increase the probability of victory and the loss in the case of losing a war and so its net effect is ambiguous [1].

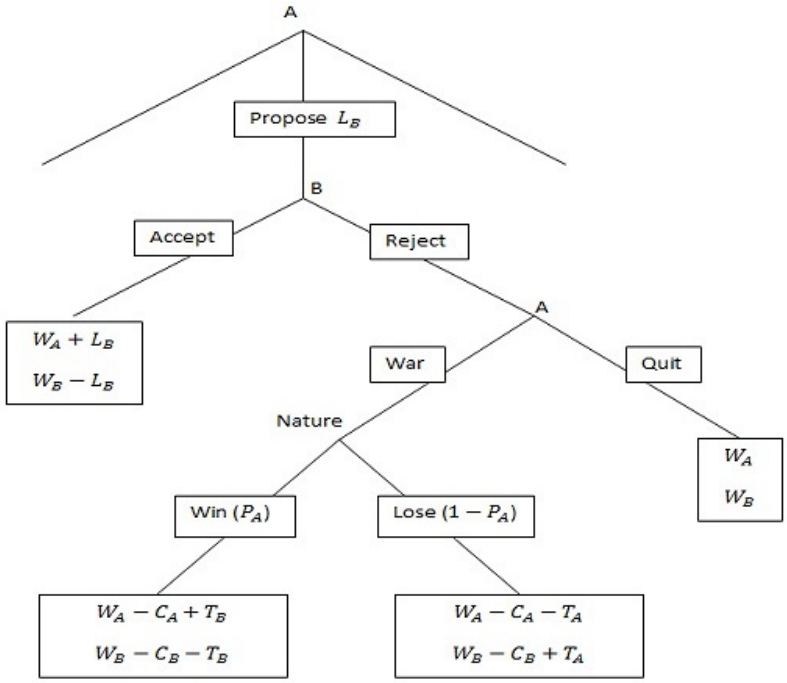
[1] As a higher level of wealth means that a government has higher military capability, this implies that if countries have military capabilities in proportion to their wealth, richer countries win more often. However, a rich country has more to lose compared to a poorer country once it is defeated

1.3.1 Basic Model

There are two countries, country A and country B, each with initial endowment W_A and W_B. At first, country A proposes a 'L_B' ($0 < L_B \leq W_B$) for country B to give up and transfer to country A. Country B decides whether to accept or reject A's proposal. If B accepts, country A gets 'L_B' and B loses 'L_B', so the total payoff vector of the two countries will then be $(W_A + L_B, W_B - L_B)$.

If country B rejects the proposal, then country A decides whether to start a war or quit the bargaining. If A quits, both A and B maintain their endowments, which is (W_A, W_B). If A chooses to start a war, then country A wins with a probability P_A which depends on relative military strength. If A wins, it gets a transfer T_B from country B. Otherwise, A loses and country B gets a transfer T_A from country A. Both countries pay a cost C_A and C_B when war happens. The extensive form of the game is shown in Figure 1.1.

Figure. 1.1 *Extensive Form of Basic Bargaining Game*



Analysis

There are two situations we will discuss. First, when the probability of victory for country A is not big enough, that is $P_A \leq \frac{C_A+T_A}{T_A+T_B}$ (See Appendix A.1), country A's expected payoff from war is less than quitting the bargaining if it gets rejected by country B. Knowing that, country B will reject any proposal.

Second, when $P_A > \frac{C_A+T_A}{T_A+T_B}$, the maximum that country A can propose to avoid war is

$$maxL_B = P_A(T_A + T_B) - T_A + C_B$$

Now we consider whether country A would like to propose a L_B which is bigger than $maxL_B$ so that war will happen.

a **If** $L_B = maxL_B$

If country A proposes $maxL_B = P_A(T_A + T_B) - T_A + C_B$, its final payoff will be

$$E_A(maxL_B) = W_A + maxL_B = W_A + P_A(T_A + T_B) - T_A + C_B$$

b **If** $L_B > maxL_B$

If country A proposes a L_B which is bigger than $maxL_B$, war will be initiated eventually. Country A's expected payoff from war is

$$E_A(> maxL_B) = P_A(W_A - C_A + T_B) + (1 - P_A)(W_A - C_A - T_A)$$

$$= W_A + P_A(T_A + T_B) - T_A - C_A$$

As long as the costs of war are non-negative: $C_A \geq 0$ and $C_B \geq 0$, we have $E_A(maxL_B) \geq E_A(> maxL_B)$. Hence, country A will not propose more than $maxL_B$.

Characterisation of Equilibria

• When $P_A \leq \frac{C_A+T_A}{T_A+T_B}$, country A will quit after being rejected by B, therefore country B will reject any proposal country A proposes.

• When $P_A > \frac{C_A+T_A}{T_A+T_B}$, country A will propose exactly $maxL_B$ and since country B is indifferent between accepting and rejecting it will accept the proposal.

We do not discuss the endogeneity of the winning probability for country A (P_A) and the war costs in this section, as war will not happen in both equilibria we characterised under any parameter value. This confirms Fearon's (1995) opinion that rational agents with complete and consistent information would prefer a settlement that provides better outcomes rather than costly war. We will link these variables with the economic wealth of the two countries in the next section.

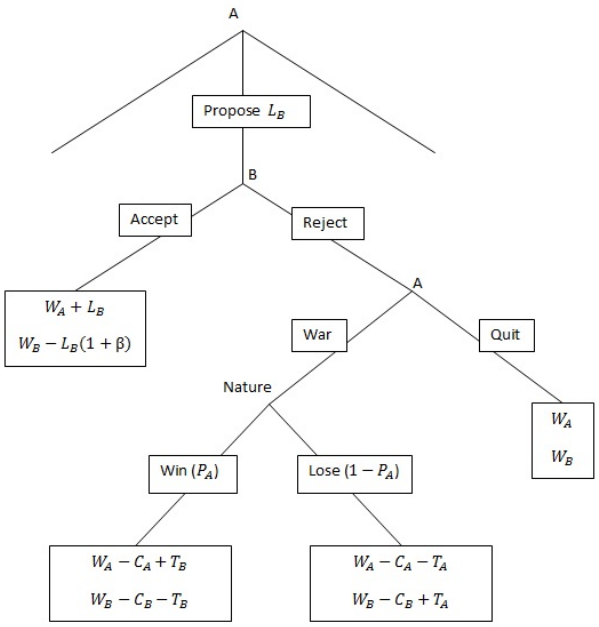
1.3.2 Non-transferable Benefits

Non-transferable benefit is the part that target country gains from its own possessions and cannot be gathered by the aggressor. This could be because the target country values this part of the benefits over the actual value that the rival could gain. To apply this idea, we assume there is an additional loss for country B when it compromises and accepts A's proposal. Additional loss occurs only when concession happens [2], which can be understood as the loss of prestige of surrender. The total payoff for country B if it accepts the proposal will be: $W_B - L_B(1+\beta)$ where $\beta > 0$. Because country A cannot gather additional benefits from that concession, it will still get: $W_A + L_B$ [3]. The game becomes:

[2] There is no additional loss when country B loses the war and needs to make transfer to its rival.

[3] This is identical with that country B loses $W_B - L_B$, but country A receives less: $W_A + L_B(1-\beta)$. The analysis will be consistent.

Figure. 1.2 *Extensive Form of Game with Non-transferable Benefits*



Equilibrium Analysis

The maximum amount that country A can propose to avoid war becomes

$$maxL_B = \frac{1}{1+\beta}[P_A(T_A+T_B) - T_A + C_B]$$

which is smaller than that in the basic model as $\frac{1}{1+\beta} < 1$. With non-transferable benefits, the transfer country B is willing to pay for peace is less, which in turn increases country A's incentive for going to war. Again, we compare country A's expected payoffs from two strategies:

a **If** $L_B = maxL_B$

If country A proposes exactly $maxL_B$ so that the war will not happen, its final payoff will be

$$E_A(maxL_B) = W_A + \frac{1}{1+\beta}[P_A(T_A+T_B) - T_A + C_B]$$

b **If** $L_B > maxL_B$

If country A proposes a L_B which is bigger than $maxL_B$, war will be initiated eventually. Country A's expected payoff from war does not change:

$$E_A(> maxL_B) = P_A(W_A - C_A + T_B) + (1-P_A)(W_A - C_A - T_A)$$

$$= W_A + P_A(T_A+T_B) - T_A - C_A$$

Because country A is receiving less from concession than in basic model, it is possible that the expected payoff from war exceeds the final payoff from concession by proposing exactly $maxL_B$. This is when:

$$W_A + \frac{1}{1+\beta}[P_A(T_A+T_B) - T_A + C_B] < W_A + P_A(T_A+T_B) - T_A - C_A$$

Rearrange it, and we have the condition for the initiation of war:

$$P_A > \frac{T_A + \frac{1+\beta}{\beta}C_A + \frac{1}{\beta}C_B}{T_A+T_B} \tag{1.1}$$

As long as condition (1.1) is satisfied, country A's expected payoff from war outweighs its maximum payoff from remaining at peace, hence starting a war becomes the best choice for country A.

Interpretation

We are interested in how economic factors affect condition (1.1). To achieve that, we will discuss each element on both hand sides of the condition as follows:

The Probability of Victory and Military Capability Firstly, when considering a war it is essential to look at what decides the probabilities of victory in different countries. Collier and Hoeffler (1998) claim that the probability of victory depends upon the capability of the government to defend itself, and that the military capability of the government depends upon its military expenditure. However, in a situation of inter-state war, the probability of either side's victory depends upon both sides' military proficiency (Kydd, 2000). Therefore, the probability of victory for country A (P_A) should be a function of the military capability of A and B, denoted by M_A and M_B respectively.

$$P_A = P(M_A, M_B)$$

It should increase in M_A and decrease in M_B: $\frac{\partial P_A}{\partial M_A} > 0$, $\frac{\partial P_A}{\partial M_B} < 0$. Similarly, the probability of victory for country B would be $P_B \equiv P(M_B, M_A) = 1 - P_A$, and $\frac{\partial P_B}{\partial M_B} > 0$, $\frac{\partial P_B}{\partial M_A} < 0$. We assume either country A defeats country B or the other way around, so there is no situation where both countries win. [4]

[4] P_A, P_B should also have following properties:

$$\lim_{M_A \to 0} P_A = 0, \lim_{M_A \to \infty} P_A = 1, \lim_{M_B \to 0} P_A = 1, \lim_{M_B \to \infty} P_A = 0$$

$$\lim_{M_B \to 0} P_B = 0, \lim_{M_B \to \infty} P_B = 1, \lim_{M_A \to 0} P_B = 1, \lim_{M_A \to \infty} P_B = 0$$

A general form of contest success function, which provides a way to determine the winning probability in conflict, takes the following additive form:

$$P_A = P(M_A, M_B) = \begin{cases} \frac{f(M_A)}{f(M_A)+f(M_B)} & \text{if} \quad f(M_A)+f(M_B) > 0 \\ \frac{1}{2} & \text{otherwise,} \end{cases}$$

where f(.) is a non-negative, increasing function. This class has been employed in a number of fields, including in the economics of advertising, sports economics, rent-seeking, and contests in general. (Garfinkel and Skaperdas, 2007)

Assuming military capability is closely related with wealth level, each side of a dispute puts a certain part of its endowment into military expenditure which is viewed as representative of military capability.

$$M_A = \theta_1 W_A \quad M_B = \theta_2 W_B$$

The most commonly used functional form is the one in which $f(M) = M^m$, where $m > 0$ (and often, for technical reasons, $m < 1$). So that

$$P_A = \frac{(\theta_1 W_A)^m}{(\theta_1 W_A)^m + (\theta_2 W_B)^m}$$

War Cost Economic cost of a violent conflict or war can be classified as either direct or indirect costs. Direct costs are those that are immediately attributable to the conflict, such as destruction and damage to capital assets and labour etc.. Indirect costs include those

that are the by-products of the conflict, and may include capital flight, loss of potential foreign capital and tourist inflows and emigration of skilled labour (Arunatilake et al., 2001). Intuitively, regardless of winning or losing, both direct and indirect costs should increase with countries' wealth, as richer country would have more (aggregate amount) to lose during the warfare, including capital assets and skilled labour as well as potential capital flight and so on. Expressed by equations, these are:

$$C_A \equiv C(W_A) \quad \text{and} \quad \frac{\partial C_A}{\partial W_A} > 0$$

We follow a simple form of definitions in Jackson and Morelli (2007): a war costs a fraction of a state's wealth, and that the transfer would be a share of what is left after diminishing military expenditure and war cost.[5] Therefore, they are defined as follows:

$$C_A = \sigma_1 W_A, \quad C_B = \sigma_2 W_B$$

$$T_A = \alpha_1(1-\theta_1-\sigma_1)W_A, \quad T_B = \alpha_2(1-\theta_2-\sigma_2)W_B$$

All coefficients θ_1, θ_2, σ_1, σ_2, α_1, $\alpha_2 \in [0,1]$. Therefore, condition (1.1) becomes

$$\frac{(\theta_1 W_A)^m}{(\theta_1 W_A)^m + (\theta_2 W_B)^m} > \frac{\alpha_1(1-\theta_1-\sigma_1)W_A + \frac{1+\beta}{\beta}\sigma_1 W_A + \frac{1}{\beta}\sigma_2 W_B}{\alpha_1(1-\theta_1-\sigma_1)W_A + \alpha_2(1-\theta_2-\sigma_2)W_B}$$

[5] We could also use fixed costs and/or benefits. However, it does not make very much change to the qualitative analysis of the model.

Rearrange it, and we have

$$\begin{aligned}\theta_1^m[\alpha_2(1-\theta_2-\sigma_2)-\sigma_2\frac{1}{\beta}] > \theta_1^m\sigma_1(1+\frac{1}{\beta})\frac{W_A}{W_B}+\theta_2^m\sigma_2\frac{1}{\beta}(\frac{W_B}{W_A})^m \\ +\theta_2^m[\alpha_1(1-\theta_1-\sigma_1)+\sigma_1(1+\frac{1}{\beta})](\frac{W_B}{W_A})^{m-1}\end{aligned} \tag{1.2}$$

The left hand side is composed of parameters, while the right hand side can be seen as a function of $\frac{W_B}{W_A}$. We rewrite the right hand side of inequality (1.2) as

$$G(X)=\theta_1^m\sigma_1(1+\frac{1}{\beta})\frac{1}{X}+\theta_2^m\sigma_2\frac{1}{\beta}X^m+\theta_2^m[\alpha_1(1-\theta_1-\sigma_1)+\sigma_1(1+\frac{1}{\beta})]X^{m-1}$$

where X=$\frac{W_B}{W_A}$. It can be shown that the first order derivative of $G(X)$ is strictly monotonic:

$$G'(X)=-\theta_1^m\sigma_1(1+\tfrac{1}{\beta})\tfrac{1}{X^2}+m\theta_2^m\sigma_2\tfrac{1}{\beta}X^{m-1}+(m-1)\theta_2^m[\alpha_1(1-\theta_1-\sigma_1)+\sigma_1(1+\tfrac{1}{\beta})]X^{m-2}$$

We solve first order condition $G'(X)=0$ and get

$$m\theta_2^m\sigma_2\frac{1}{\beta}X^{m+1}+(m-1)\theta_2^m[\alpha_1(1-\theta_1-\sigma_1)+\sigma_1(1+\frac{1}{\beta})]X^m=\theta_1^m\sigma_1(1+\frac{1}{\beta}) \tag{1.3}$$

Assume the solution to (1.3) is X^* ($X^*=\sqrt{\frac{\theta_1\sigma_1}{\theta_2\sigma_2}(1+\beta)}$ when m=1). The right hand side of condition (1.2) decreases with X as long as $X<X^*$, meanwhile the condition (1.1) would be more likely to be satisfied, thus war proneness increases. On the contrary, when $X>X^*$, that is, when the relative wealth level ($\frac{W_B}{W_A}$) exceeds a threshold, the increase of $\frac{W_B}{W_A}$ reduces the likelihood of the outbreak of war. We can interpret this finding as follows:

Proposition 1.1. *There is a threshold value X^*, which is the solution to equation (1.3). When $\frac{W_B}{W_A} \leq X^*$, the probability of war increases with relative wealth $\frac{W_B}{W_A}$; when $\frac{W_B}{W_A} > X^*$, the probability of war decreases with $\frac{W_B}{W_A}$.*

If $\frac{W_B}{W_A} \leq X^*$, which means the target country is relatively poor compared with the initiator, the higher $\frac{W_B}{W_A}$ implies the initiator is able to extract more in case of victory or has less to lose once being defeated. Therefore, the incentive for war is enhanced, which leads to a higher probability of war. On the contrary, if $\frac{W_B}{W_A} > X^*$, the relative wealth level is high enough, then a higher $\frac{W_B}{W_A}$ implies a disadvantaged position for the initiator who is, hence, less likely to go to war.

Although we do not know the exact value of X^*, we can see from equation (1.3) that X^* clearly decreases with θ_2 and σ_2. It can be easily understood that the increase of θ_2 (military expense of targeted country) could cause a more disadvantaged position for the initiator given the same level of relative wealth, resulting in a smaller threshold of $\frac{W_B}{W_A}$. The negative impact of σ_2 is less obvious. This could be because the increase of war costs for targeted country reduces the wealth that the initiator would be able to extract in case of victory, which off-setts the economic incentives and lowers the threshold. Moreover, if we do not consider the level of technology (assuming m=1), $X^* = \sqrt{\frac{\theta_1\sigma_1}{\theta_2\sigma_2}(1+\beta)}$, it appears that X^* also increases with θ_1, σ_1 and β. The effects of the former two factors can be explained by reversing previous illustrations. The increase of β represents the higher non-transferability of the benefits held by targeted country. It means that as the targeted country values its own possessions more, the relative wealth level that causes the highest

probability of war increases.

1.4 Empirical Analysis

Based on the discussion above, it has been shown that the relative wealth level (represented by $\frac{W_B}{W_A}$) between two states involved in a dispute should have a significant impact on an aggressive country's war likelihood, as well as the occurrence of war. When the target country is relatively poor compared with the initiator of the dispute, the higher $\frac{W_B}{W_A}$ leads to a higher probability of war. If the relative wealth level is high enough, a higher $\frac{W_B}{W_A}$ implies a disadvantaged position for the initiator who then is less likely to go to war. Hence, we expect a non-monotonic relationship between relative wealth and the occurrence of war. This section sets out the empirical analysis that tests the effect of relative economic aggregates on states' behaviour over initiating a war. Data, including states' total wealth level, are used to test its significance on influencing the probability of conflict escalation.

1.4.1 Data and Methodology

Data

Data on Inter-state Conflict: Militarized Interstate Dispute dataset (COW)

One basic dataset that will be used is Version 4 of the Militarized Interstate Dispute (MID) data collection from the Correlates of War (COW) Project (Jones et al., 1996). The Correlates of War (COW) Project has utilized a classification of wars that is based upon the status of territorial entities, in particular, focusing on those that are classified

as members of the inter-state system (referred to as 'states'). The MID dataset provides information about conflicts in which one or more states have threatened, displayed, or used force against one or more other states between 1816 and 2010. We will analyse the data at the dyadic level, hence each observation refers to both the countries which participated in each military dispute. We define each dyad-year as the year the dispute starts. Besides, in this chapter, the war is defined to occur when the dispute escalates (that is if the highest level of hostility, reached by either side of the dyad, exceeds a certain level).

Data on Wealth Level: The New Maddison Project Database

For the measurement of Wealth, Maoz and Russett (1993) use the Penn World Table by Summers and Heston(1988). This dataset provides purchasing power parity and national income accounts converted to international prices for 189 countries/territories. It has been updated to cover some or all of the years during 1950-2010. The problem of using that dataset for the current research is that it only covers the period after 1950. However, there are a huge number of military disputes that happened before the twentieth century. For this reason, economic data will be needed for the earlier period. The New Maddison Project Database solves this problem. The Maddison Project initiated in March 2010 measures economic performance for different regions and time periods. The New Maddison Project Database is an updated version of the original Maddison dataset, incorporating much of the latest research in the field, and presents new estimates of economic growth in the world economy between AD 1 and 2010. [6]

[6]The Maddison-Project, http://www.ggdc.net/maddison/maddison-project/home.htm, 2013 version.

Data on Regime Types: Individual Country Regime Trends dataset (Polity IV Project) The data to measure the form of government, or "regime", come from the Individual Country Regime Trends in Polity IV Project (Marshall and Jaggers, 2002), which has been updated and extended to the period from 1800 to 2013. The Polity IV project continues the Polity research tradition of coding the authority characteristics of states in the world system. The levels of democracy and autocracy are treated as variables, and derived from coding of the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive (an additional variable for the indicator of autocracy: the regulation of political participation).

Other datasets: Correlates of War (COW) Project

Data on Major Power: Majors2011 Dataset

This dataset identify major powers in the international system.

Data on Alliance: Formal Interstate Alliance Dataset

This dataset records all formal alliances among states that fall into the classes of mutual defence pact, neutrality or non-aggression treaty, or entente agreement between 1816 and 2012.

Data on Direct Contiguity: Dyadic Direct Contiguity Dataset

Direct Contiguity dataset identifies all direct contiguity relationships between states in the

international system from 1816 through 2006. Derived from these data, the Dyadic Direct Contiguity file includes annual records for each (directional) pair of states that is directly contiguous.

Data on Diplomatic Exchange: Diplomatic Exchange Dataset

The Diplomatic Exchange dataset tracks diplomatic representation and diplomatic exchange at the level of *Chargé d'Affairs*, minister, and ambassador between states from 1817-2005.

Data on Military Balance: National Material Capabilities Data

This dataset contains annual values for total population, urban population, iron and steel production, energy consumption, military personnel, and military expenditure of all state members, currently from 1816-2007. The widely-used Composite Index of National Capability (CINC) is calculated based on these six variables and included in the dataset.

Variables

Conflict escalation: *War*

It is widely recognized that wars occur in at least two stages: the outbreak of a dispute between states and the escalation of this dispute to the point where force is applied (Snyder and Diesing, 1977). In most previous studies, empirical analysis has been focused on the occurrence of militarized dispute. However, we cannot simply equate the causal linkages for MIDs and wars. There could be many non-economic factors that trigger militarized

disputes. With respect to our theoretical model, we are more interested in the economic considerations that could influence the escalation of disputes which directly leads to war. Thus, we concentrate on the instances in which an identifiable decision was taken either to start or significantly escalate an incident (Hess and Orphanides, 1995). Each dispute in MID dataset is coded with a hostility level ranging from 1 to 5 ((1=No militarized action, 2=Threat to use force, 3=Display of force, 4=Use of force, 5=War). Following Hess and Orphanides, the definition of war would be when the hostility level reached by one or both states in dispute is above 3 (including 'Use of force' and 'War'). That is War=1 when the hostility level of either country > 3; War=0 otherwise.

GDP per capita ratio: $RE = \frac{GDPpcB}{GDPpcA}$, and $RE2 = RE^2$

The official estimates of GDP per capita is used to measure country's wealth. It is calculated based on the Geary–Khamis (International) dollar in 1990. And so RE would be a proxy of relative wealth of country A to country B ($\frac{W_B}{W_A}$). We also define a RE2 as the squared term of RE. This is because a non-monotonic relationship between relative wealth level and occurrence of war is found by the end at the theoretical section and the squared term is set to capture this feature.

Control variables: We include the main controls typically considered in the literature that explores causes of war (*Names of variables in parentheses*):

Joint Democracy (*demdem*): The key variable that will be used is "POLITY2", which is the

revised combined POLITY score. The POLITY score is computed by subtracting the autocracy score (AUTOC) from the democracy score (DEMOC); the resulting unified polity scale ranges from +10 (strongly democratic) to -10 (strongly autocratic). Following Baliga et al. (2011), a country with a POLITY2 score higher than 3 is defined as a democracy and with a POLITY2 lower than -3 is defined as an autocracy [7]. Joint democracy, *demdem*, is included to account for the impact of dyadic regime characteristics. Hence, *demdem*=1 if the polity levels of both countries $>= 3$ and *demdem*=0 when at least one side has a polity level lower than 3. If we expect 'democratic peace' to be found, the effect of *demdem* on the occurrence of war would be negative.

Major Power (*MajorPower*): dummy variable which is coded as 1 if at least one of the two countries is a major power at time t. It has been reported that major power in the world more likely to be involved in conflicts.

Nonaggression Agreement (*Nonaggression*): dummy variable which is coded as 1 if both sides in the observation signed terms that included a promise of non-aggression toward one or more states in the alliance. Intuitively, this term should have negative impact on the likelihood of war.

Direct Contiguity (*DirCon*): dummy variable which is coded as 1 if there exists a direct contiguity relationship between two states at specific year in observations. Contiguous states are expected to have more territery disputes. The impact on conflict escalation is not

[7] Baliga et al. (2011) define that a dictatorship corresponds to values smaller than -3, a limited democracy to values between -3 and 3, and a full democracy to values greater than 3.

clear.

Log of Distance (*LnDist*): the log of the distance between the two capital cities of the dyad. Similarly, two countries with far distance should be less likely to use force agarint each other.

Diplomatic Exchange (*DiploEx*): dummy variable which is coded as 1 if there is any diplomatic exchange between both sides in that year. Diplomatic exchange could be a sign of good relationship between two countries, and thus has negative impact on war. However, in some cases, it could also be a sign of bad relationship as there might be conflicts of interest need to be resolved.

Military Balance (*MilitaryBalance*): defined as the log of the ratio of the Composite Index of National Capability (CINC) index of the stronger to the weaker country in each dyad (Conconi et al., 2014). The gap of military force is normally considered to have positive effect on the probability of war. The bigger the gap is, the more likely war will occur.

Table 1.1 *Descriptive Statistics of the Variables*

Variable	Definition	Observation	Mean	Std. Dev.
War	Dummy variable indicates conflict escalation	3,768	0.7186837	0.4497012
RE	GDP per capita ratio	1,530	2.741868	4.313898
RE2	Square term of GDP per capita ratio	1,530	26.11539	116.8577
demdem	Dummy variable indicates joint democracy	3,449	0.1029284	0.3039094
MajorPower	Dummy variable indicates at least one major power state	3,768	0.4455945	0.4970972
Nonaggression	Dummy variable indicates whether non-aggression agreement is signed	3,768	0.141189	0.3482626
DirCon	Dummy variable indicates whether there is direct contiguity	3,768	0.531051	0.4991011
LnDist	Log of distance between two capital cities	3,028	7.388705	1.181831
DiploEx	Dummy variable indicates whether there is diplomatic exchange	3,768	0.1491507	0.3562843
MilitaryBalance	Log of the ratio of CINC index of the stronger to the weaker country	3,186	2.012928	1.596091

Table 1.1 displays the descriptive statistics of each variable. The dependent variable *War* is a dummy that indicates conflict escalation with mean at 0.72 and standard deviation at 0.45, which shows a relatively high frequency of war among all MIDs (militarized interstate disputes). The mean of relative wealth, proxied by the GDP per capita ratio *RE*, is about 2.74, thus the target is normally more than twice as wealthy compared to the initiator. We also observe that almost half of the MIDs involve at least one major power, and more than half MIDs happened between two contiguous countries.

Empirical Model

The empirical model we use is a panel logit regression model at the dyadic level. The logit regressions consider possible factors that affect the probability of conflict escalation. The

dependent variable is the probability that war occurs for each dyad (country A and B) in a militarized dispute at time t. The independent variables include relative wealth level, the squared term of relative wealth, and other control variables.

Logit Model:

$$Prob\{War_{AB,t} = 1\} = F(\alpha + \beta_1 RE_{AB,t} + \beta_2 RE2_{AB,t} + \beta_3' X_{AB,t}) \tag{1.4}$$

F() is the cumulative distribution function of a logistic distribution. As explained before, we define $War_{ABt} = 1$ when hostility level of either country > 3 at time t; $War_{ABt} = 0$ otherwise. Only country pairs with at least one militarized dispute occurring in particular years are included in the data, hence we only look at whether these disputes escalate to war. Those years with no militarized dispute occurred were also excluded. RE_{ABt} represents relative wealth level of the targeted country over the aggressive country, $\frac{GDPB}{GDPA}$, and $RE2_{ABt} = RE_{ABt}^2$. X_{ABt} is a vector of controls and includes dummies for joint democracy, major power, non-aggression term (alliance), direct contiguity, diplomatic exchange as well as log of distance and military balance.

1.4.2 Results

The Baseline

Table 1.2 shows the results of pooled, random effects and fixed effects logit models. Models (2), (4) and (6) include year-fixed effects to control for unobserved time-varying effects.

The first two columns use pooled maximum likelihood estimation (MLE) and columns (3) and (4) are the logit models with random effects. The average partial effects (APE) of each regressor instead of coefficients are reported for these models [8]. Columns (5) and (6) are the conditional logit models, or fixed effects logit models, which take dyad fixed effects into account. However, the partial effects in fixed effect models depend on the fixed effects that cannot be estimated, hence only coefficients are reported. Fortunately, we are only interested in the non-monotonic impact of relative wealth (measured as GDP per capita ratio - *RE*) which can still be observed from the sign of estimated coefficients. The year-fixed effects are included in models (2), (4) and (6) to account for the impact of worldwide economic fluctuations or other factors that are common to both sides in a dyad and so affect their incentives to be aggressive [9].

[8] We report APE instead of partial effect at the average (PEA), because if the explanatory variables contain non-linear functions of underlying variables (such as *RE2*), especially when *RE* and *RE2* are functionally related, the PEAs do not tell the partial effect of RE since it calculates the average of the non-linear function not the non-linear function of the average (Wooldridge (2010), p. 575). Another reason is that most of the other controls are dummies in our models and for discrete variables PEAs do not represent the partial effect at any particular level.

[9] Wald test confirms the use of year-fixed effects.

Table 1.2 *Logit Estimates of the Impact of Relative Wealth (using GDP per capita from Maddison Project) on Conflict Escalation, 1816-2010*

	(1)	(2)	(3)	(4)	(5)	(6)
War	Pooled MLE APE	Pooled MLE APE	Random Effects APE	Random Effects APE	Fixed Effects Coefficient	Fixed Effects Coefficient
RE	0.0439***	0.0458***	0.0474***	0.0508***	0.333***	0.358***
	(0.0100)	(0.00841)	(0.0121)	(0.00940)	(0.0977)	(0.134)
RE2	-0.00168***	-0.00170***	-0.00176***	-0.00184***	-0.0121**	-0.0124*
	(0.000585)	(0.000431)	(0.000667)	(0.000473)	(0.00482)	(0.00642)
demdem	-0.0927**	0.0288	-0.122**	0.0122	-0.326	-1.482
	(0.0394)	(0.0405)	(0.0493)	(0.0469)	(0.564)	(1.275)
MajorPower	-0.0851**	-0.0956***	-0.0840*	-0.0998**	-0.347	-4.065**
	(0.0335)	(0.0362)	(0.0434)	(0.0413)	(0.739)	(1.788)
Nonaggression	-0.0333	-0.0215	-0.0445	-0.0260	-1.292***	-1.144
	(0.0344)	(0.0341)	(0.0410)	(0.0394)	(0.487)	(0.814)
DirCon	-0.0274	0.0290	-0.0199	0.0398	0.393	1.111
	(0.0405)	(0.0405)	(0.0450)	(0.0421)	(0.698)	(1.781)
Lndist	0.0120	0.0213	0.0237	0.0330		
	(0.0178)	(0.0190)	(0.0215)	(0.0214)		
DiploEx	0.00733	0.0412	0.00979	0.0595	0.104	0.195
	(0.0376)	(0.0683)	(0.0408)	(0.0607)	(0.330)	(0.864)
MilitaryBalance	0.0228**	0.00403	0.0249**	0.00345	0.970***	-0.336
	(0.00989)	(0.0102)	(0.0121)	(0.0110)	(0.298)	(0.573)
Dyad fixed effects	no	no	no	no	yes	yes
Year fixed effects	no	yes	no	yes	no	yes
Observation	1236	1106	1236	1106	542	542
pseudo R^2	.035	.163	.036	.166	.068	.506
Log lik.	-742.9	-584.3	-734.0	-577.2	-193.4	-102.4
Chi-squared	53.85	227.1	54.72	230.5	28.15	210.1

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The fixed effects logit model employs Chamberlain's method of conditional fixed effects. This cannot be done for probit model because probits do not have a closed form solution. It has to be mentioned that, despite having been used repeatedly, this technique has significant drawbacks especially when the group sizes are not big. An alternative way is to use linear probability model, which will be introduced later.

As we can see from Table 1.2, the effects of the relative wealth level (*RE*) are significant and positive, and the effects of its squared term (*RE2*) are significant and negative in all models. Althought the estimates of *RE2* tend to be less significant in the fixed effects models, we can still confirm there is a non-monotonic relation between relative wealth level and the escalation of conflict. Besides that, whether both countries are democracies seems to have an impact on conflict escalation only in the pooled and random effects models without year-fixed effects. It shows that if both countries are democracies they are 9.2% and 12.2% respectively less likely to get involved in war. Moreover, whether both countries have signed a non-aggression agreement is negatively related to the conflict escalation, as expected. This effect is significant only in the country-fixed effects models without year-fixed effects (Model (5)).

According to the first four models, if either country is a major power, this reduces the risk of war by about 8.5-10%, and the effect is only statistically insignificant in model (5). The reason for this negative effect is unclear, as most literature suggest that a major power is more likely to get involved in military conflict. Yet it is not difficult to understand once we realize we are looking specifically at the escalation of conflict. In other words, a major power may originally be more likely to get involved in military conflict; however, once they have already had militarized disputes with other states, the major power may tend to be more cautious about actually starting a war. Finally, the bigger the gap of national power between two states (*MilitaryBalance*), the more likely they are going to escalate the dispute into war; although, this effect is only significant in models when year-fixed effects are not included. The distance between two states, or diplomatic exchanges may

have had seem to have no impact on conflict escalation.

According to model (1), the probability of war increases with the relative wealth *RE* before *RE* reaches around 13 (calculated from $[-\frac{\hat{\beta}_2}{2\hat{\beta}_1}]$) and then declines with a decrease in *RE*. That is, as long as the economic wealth level of a targeted country is less than 13 times that of the aggressor, an increase in RE would raise the risk of war. This number is slightly larger in other models, which is approximately 13.5 in models (2) and (3); and 13.8 in models (4) and (5). The coefficient magnitudes are difficult to interpret for the fixed effects logit models, but the ratio of coefficients calculated as critical value of RE are 13.8 and 14.5 with and without dyad fixed effects respectively, which are not remarkably different from the other models.

As for choosing between fixed and random effects, first we run a Breusch-Pagan LM test for the random effects LPM based on the OLS residual (See Appendix A.2). The p-value is highly significant, which indicates that we should not be using OLS. We then use the Hausman test to test for fixed versus random effects (See Appendix A.3). The result of a Hausman test for models (3) and (5) is not significant at 5% confidence level, which shows no significant differences between the coefficients for the fixed effects and the random effects models. Additionally, since the traditional Hausman test is only valid under homoscedasticity and cannot be conducted when including the year-fixed effects, we test the unrelatedness assumption in random effects models by running an auxiliary regression, where we include the time averages of all time-varying regressors and jointly test the time averages (Mundlak, 1978; Wooldridge, 2010, p.332, eq.10.88). It turns out

that we cannot reject the null hypothesis and, thus, the unrelatedness assumption is not rejected. Both tests suggest it is possible that random effects models will be more efficient.

1.4.3 Robustness Checks

Alternative Empirical Specification

We now have a look at an alternative empirical model - the linear probability model. Here, simple linear regressions consider factors that affect probability of conflict escalation.

Linear Probability Model:

$$Prob\{War_{AB,t} = 1\} = \alpha + \beta_1 RE_{AB,t} + \beta_2 RE2_{AB,t} + \beta_3' X_{AB,t} + \varepsilon_{AB,t} \tag{1.5}$$

It should be noted, however, that there are some problems with the linear probability model when dealing with binary outcome variables, such as heteroscedastic standard errors (Long and Ervin, 2000), and more seriously, nonsensical predictions can occur (the predictions of probabilities are not constrained within the range between 0 and 1). Besides, due to the inconsistency of the effects of X on Y it would be very hard to make sense of the average effect. However, it allows us to evaluate the robustness of our baseline results. Moreover, it allows us to compare the magnitudes of the variables concerned in the probability of conflict escalation in the fixed effects models.

Basically, the linear models (Table 1.3) provide similar results: the positive effect of

relative wealth level (RE) and the opposite effect of its squared term (RE2) are still significant in all models except model (5). Again, joint democracy has an ambiguous impact on

Table 1.3 *Linear Probability Estimates of the Impact of Relative Wealth (using GDP per capita from Maddison Project) on Conflict Escalation, 1816-2010*

	(1)	(2)	(3)	(4)	(5)	(6)
War	Pooled	Pooled	Random Effects	Random Effects	Fixed Effects	Fixed Effects
RE	0.0404***	0.0413***	0.0408***	0.0416***	0.0631**	0.0577***
	(0.00886)	(0.00807)	(0.0102)	(0.00879)	(0.0257)	(0.0201)
RE2	-0.00159***	-0.00147***	-0.00155***	-0.00146***	-0.00227	-0.00189*
	(0.000527)	(0.000415)	(0.000591)	(0.000442)	(0.00139)	(0.00101)
demdem	-0.101**	0.0310	-0.116**	0.0245	-0.0192	-0.0263
	(0.0447)	(0.0480)	(0.0510)	(0.0549)	(0.0956)	(0.110)
MajorPower	-0.0884**	-0.0920**	-0.0799*	-0.0899**	-0.0240	-0.291
	(0.0345)	(0.0379)	(0.0410)	(0.0433)	(0.218)	(0.221)
nonaggression	-0.0360	-0.0177	-0.0413	-0.0187	-0.256**	-0.284*
	(0.0357)	(0.0375)	(0.0396)	(0.0419)	(0.113)	(0.153)
DirCon	-0.0267	0.0266	-0.0184	0.0313	0.0770	0.190
	(0.0414)	(0.0420)	(0.0428)	(0.0463)	(0.135)	(0.190)
lndist	0.0121	0.0180	0.0192	0.0215		
	(0.0184)	(0.0196)	(0.0203)	(0.0233)		
DeploEx	0.00843	0.0435	0.00899	0.0488	0.0179	-0.0230
	(0.0384)	(0.0759)	(0.0384)	(0.0763)	(0.0537)	(0.0906)
MilitaryBalance	0.0233**	0.00304	0.0226**	0.00230	0.167***	-0.0200
	(0.00983)	(0.00980)	(0.0111)	(0.0106)	(0.0558)	(0.0644)
_cons	0.544***	0.925***	0.485***	0.897***	0.265*	0.753***
	(0.153)	(0.146)	(0.168)	(0.174)	(0.147)	(0.245)
Observation	1236	1236	1236	1236	1236	1236
R-squared	.042	.260	.041	.260	.050	.327

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

conflict escalation. Models (1) and (3) show that it can reduce the risk of war whereas models (2) and (4) indicate positive effects in the case of joint democracy. Across all models, however, this effect is statistically insignificant.

Similarly, whether both countries have signed non-aggression agreement is seen to be negatively related to conflict escalation, and this is significant in two fixed effects models. If either country is a major power, it reduces the probability of conflict escalation by about 8-9%, while the gap in national power between two states (MilitaryBalance) is positively related to the probability of war. The significance of regressors is very similar to the logit models in Table 1.2 with slight differences.

Finally, the threshold value of RE (relative wealth) whose increase or decrease decides the probability of war is about 13 -14 in first five models, and slightly larger in the last model, at 15.26. However, no remarkable difference is shown, when compared to the baseline models.

Alternative Measurements of Relative Wealth

Previously, country wealth has been measured as GDP per capita and the relative wealth level has been defined as the ratio of two countries' GDP per capita. Generally speaking, GDP per capita is a measure arrived at by dividing GDP by the size of overall population. Hence, while GDP per capita determines the nation's economic health from an individual citizen's perspective, real GDP roughly measures the gross wealth of the nation. Therefore, we conduct a robustness check using real GDP as an alternative measure of a state's wealth

level.

Table 1.4 *Logit Estimates of the Impact of Relative Wealth (using real GDP from Maddison Project) on Conflict Escalation, 1816-2010*

	(1)	(2)	(3)	(4)	(5)	(6)
War	Pooled MLE APE	Pooled MLE APE	Random Effects APE	Random Effects APE	Fixed Effects Coefficient	Fixed Effects Coefficient
re	0.00525***	0.00522***	0.00582***	0.00582***	0.0569***	0.0893***
	(0.00112)	(0.00106)	(0.00125)	(0.00111)	(0.0149)	(0.0296)
re2	-0.0000131***	-0.0000133***	-0.0000142***	-0.0000143***	-0.000146***	-0.000242***
	(0.00000331)	(0.00000364)	(0.00000327)	(0.00000381)	(0.0000462)	(0.0000860)
demdem	-0.0949**	0.0193	-0.124**	0.00258	-0.350	-2.088
	(0.0380)	(0.0393)	(0.0484)	(0.0492)	(0.569)	(1.502)
MajorPower	-0.105***	-0.123***	-0.107**	-0.134***	-0.613	-5.411***
	(0.0326)	(0.0362)	(0.0427)	(0.0454)	(0.730)	(2.052)
Nonaggression	-0.0392	-0.0227	-0.0494	-0.0271	-1.335***	-1.895**
	(0.0349)	(0.0352)	(0.0417)	(0.0427)	(0.497)	(0.930)
DirCon	-0.0236	0.0348	-0.0196	0.0422	0.584	2.243
	(0.0401)	(0.0404)	(0.0454)	(0.0473)	(0.708)	(1.828)
Lndist	0.0180	0.0315*	0.0296	0.0432*		
	(0.0175)	(0.0185)	(0.0217)	(0.0237)		
DiploEx	0.00365	0.0526	0.00408	0.0669	0.0576	-0.149
	(0.0381)	(0.0674)	(0.0416)	(0.0685)	(0.331)	(0.928)
MilitaryBalance	-0.000262	-0.0204*	-0.000530	-0.0212	0.892***	-0.616
	(0.0108)	(0.0112)	(0.0135)	(0.0133)	(0.316)	(0.655)
Dyad fixed effects	no	no	no	no	yes	yes
Year fixed effects	no	yes	no	yes	no	yes
Observation	1227	1098	1227	1098	539	539
pseudo R^2	.039	.167	.040	.170	.094	.542
Log lik.	-735.5	-578.0	-726.7	-571.5	-187.1	-94.48
Chi-squared	41.15	178.0	34.14	161.6	38.66	223.8

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In Table 1.4, the terms of real GDP are generated by multiplying GDP per capita (data from Maddison Project) with the nation's total population (data from COW). The new proxy for relative wealth level would then be *re*=$\frac{GDPB}{GDPA} = \frac{GDP_{pc}B*populationB}{GDP_{pc}A*populationA} = RE * \frac{populationB}{populationA}$, and its squared term would be *re2*=re^2. If the non-monotonic relationship is robust, we should expect a positive effect of *re* and a negative effect of the squared term *re2* as before. Although after taking the size of population into account, the magnitude of the coefficients on *re* and *re2* become much smaller, the results shown in Table 1.4 confirm the predictions: the coefficients of *re* are estimated to be positive and significant in all models, while that of *re2* are negative and significant in all models. The significance and magnitude of other control variables do not change dramatically compared to the baseline models.

We also use the variable *cgdpo* from the Penn World Table (PWT 8.1) (Feenstra et al., 2015) as another measure of real GDP. The variable described as Output-side real GDP at current PPPs is based on current purchasing-power-parity (PPP), and usually used to compare relative productive capacity across countries at a single point in time. Hence, another proxy for relative wealth level would be *rgdp*=$\frac{cgdpoB}{cgdpoA}$, and its squared term would be *rgdp2*=$rgdp^2$. Table 1.5 shows the results after using data from the Penn World Table. Again, the impact of *rgdp*, the proxy for relative wealth, is positive and significant in all models, and the effect of its squared term is negative as before. The significance of *rgdp2* is strong in models (1)-(4), and is weaker in model (6), yet the impact of *rgdp2* is not significant in model (5) (conditional logit without year-fixed effects). By using PWT data that exclude pre-1950 samples, the negative impact of joint democracy becomes significant in the first five models. According to the estimated average marginal effects from models

(1)-(4), if both states are democracies there can be at least 10% less probability that they

Table 1.5 *Logit Estimates of the Impact of Relative Wealth (using real GDP from PWT) on Conflict Escalation, 1950-2010*

	(1)	(2)	(3)	(4)	(5)	(6)
War	Pooled MLE APE	Pooled MLE APE	Random Effects APE	Random Effects APE	Fixed Effects Coefficient	Fixed Effects Coefficient
rgdp	0.00602***	0.00534***	0.00627***	0.00570***	0.0931*	0.193**
	(0.00167)	(0.00155)	(0.00180)	(0.00157)	(0.0505)	(0.0907)
rgdp2	-0.00000831***	-0.00000775***	-0.00000870***	-0.00000830***	-0.000107	-0.000209*
	(0.00000232)	(0.00000232)	(0.00000247)	(0.00000261)	(0.0000886)	(0.000116)
demdem	-0.120***	-0.0875*	-0.164***	-0.113**	-1.487*	-1.460
	(0.0407)	(0.0449)	(0.0525)	(0.0568)	(0.854)	(1.432)
MajorPower	-0.165***	-0.132***	-0.171***	-0.158**	-27.16	-55.40
	(0.0479)	(0.0503)	(0.0660)	(0.0674)	(2026.7)	(30638.8)
Nonaggression	0.0287	0.0168	0.0256	0.0221	-0.534	-1.220
	(0.0443)	(0.0440)	(0.0526)	(0.0526)	(0.808)	(1.783)
DirCon	0.0123	0.0332	0.0251	0.0496	14.11	59.10
	(0.0491)	(0.0508)	(0.0583)	(0.0599)	(1159.6)	(21208.9)
Lndist	0.0374	0.0308	0.0471	0.0441		
	(0.0242)	(0.0244)	(0.0325)	(0.0320)		
DiploEx	0.0397	0.0603	0.0411	0.0928	0.147	0.493
	(0.0495)	(0.0846)	(0.0528)	(0.0866)	(0.454)	(1.058)
MilitaryBalance	-0.0177	-0.0230*	-0.0196	-0.0221	0.301	0.727
	(0.0121)	(0.0128)	(0.0163)	(0.0159)	(0.642)	(1.225)
Dyad fixed effects	no	no	no	no	yes	yes
Year fixed effects	no	yes	no	yes	no	yes
Observation	719	678	719	678	282	282
pseudo R^2	.061	.142	.056	.139	.105	.496
Log lik.	-420.3	-369.1	-412.8	-359.9	-100.0	-56.28
Chi-squared	54.54	122.2	48.54	116.2	23.39	110.9

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

will escalate a dispute to war. There is also a sign of negative impact for the index of major power. The effects of other controls are not statistically significant.

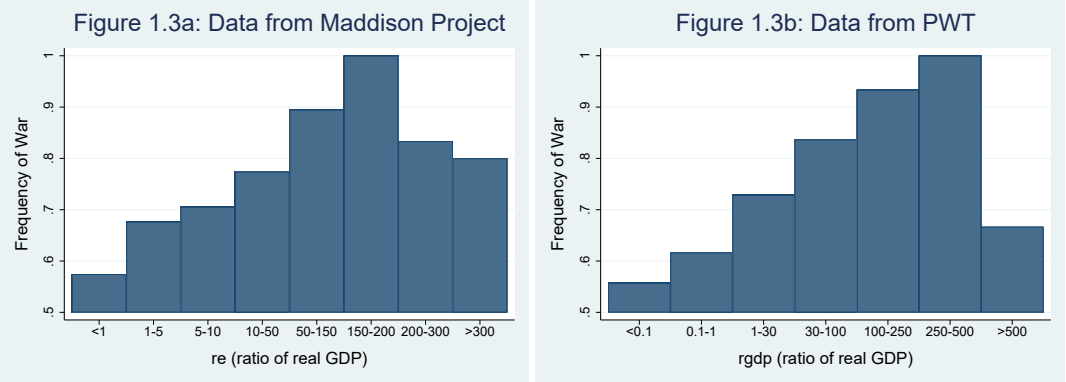
The threshold value of relative wealth is interpreted differently when we are using real GDP instead of GDP per capita as its measure. Calculated from $-\frac{\hat{\beta}_2}{2\hat{\beta}_1}$, this number varies from around 180 to 200 using Maddison Project dataset (based on the 1990 International dollar) and approximately 340-360 using data from PWT (based on the 2005 US dollar). To take the former case as an example, the probability of war increases with the relative level of aggregate wealth when the aggregate wealth level of the targeted country is less than about 180-200 times of that of the initiator. The value is much larger (340-360) if we exclude data before 1950, which implies that conflict escalation has happened more often between states with huge economic gaps between them after the 1950s.[10]

The frequency of war is calculated and plotted into graphs with relative wealth. The two graphs in Figure 1.3 shown below summarize how the frequency of war changes with the increase of relative wealth. It can be clearly seen that war happens most often when *re* is between 150 and 200 in Figure 1.3a, which corresponds with the empirical findings. A close parabolic shape can also be found in Figure 1.3b if we use economic data from the Penn World Table, and the frequency of war peaks when the ratio of real GDP is between 250 to 500, which is a wider range compared with the 340-360 that was calculated based

[10] After using real GDP instead of GDP per capita as a measurement of national wealth, the calculated relative wealth accounts for both the ratio of GDP per capita and the ratio of population between two countries. Hence, the magnitude of estimated coefficients has changed compared with the base line models.

on our estimates in Table 1.5.

Figure. 1.3 *Frequency of War with the Increase of Relative Wealth*



It is important to recall that, based on the analysis of the theoretical model, if the condition of war initiation is satisfied it implies that in actuality, both states involved in a militarized dispute prefer the outcome of war rather than peaceful agreement. Hence, it is possible the targeted country in the dispute becomes the one who starts the war in reality. Returning to the two Figures displayed above, when relative wealth is smaller than 1, that is, that the targeted state has a smaller economic aggregate size compared with the initiator, the dispute is the least likely to escalate to war. This could be because the targeted state is more likely to compromise when facing a stronger enemy. For the initiator, the positive effect of economic motives (the increase of relative wealth means an increase of economic size of targeted country and so more resources exist to acquire) on the frequency of war is obvious at the beginning, while the negative impact resulting from the fear of being defeated only appears when the power gap is huge.

1.4.4 Addressing Endogeneity Issues

We find a non-monotonic relation between relative wealth and conflict escalation: the probability of war first increases with GDP per capita ratio and then decreases with it once it exceeds a certain level. To check the robustness of the finding, we then consider possible endogeneity concerns - omitted variables bias and reverse causation.

Omitted Variables

According to Maoz and Russett (1993), rich countries tend to fight less because they are often engaged in heavy trading with each other and so the costs of a war are prohibitive. This idea is often referred by liberals as the negative effect of "economic interdependence" on war. Over the last few decades, there have been a number of studies devoted to the question of whether economic interdependence decreases or increases the likelihood of conflict. Yet there is no consensus regarding this issue. Aligning with traditional liberalism, many and perhaps most scholars conclude that interdependence fosters a co-operative inter-state relationship, and thus can greatly reduce the chance of military conflict between them (Oneal and Russet, 1997). However, other scholars argue that economic interdependence is either insignificant relative to other causes of conflict, or in fact tends to increase the probability of war due to the political incentives for reducing economic vulnerability suggested by many realists (Barbieri, 1996).

If the non-monotonic relation between relative wealth level and probability of war is caused by other factors, such as economic interdependence, that affect states' relative wealth and their war-proneness at the same time, then the previous results could be driven

by omitted variables, thus biasing our estimates. For instance, one can argue that when the relative wealth is on a small scale the increase of relative wealth indicates a growth of economic interdependence, while when the relative wealth exceeds a certain level the increase of it does not heighten economic interdependence between states or even moderate it. Another possibility is that commercial factors can both lead to peace and to military conflict (Copeland, 2014). Moreover, their impact on the outbreak of war could be positive under some conditions and negative under others. If this is the case, our finding concerning a non-monotonic relationship may be caused by economic interdependence rather than by relative wealth itself.

To address this issue, we follow the strategy of showing that the results are robust when accounting for potential effects of economic interdependence. The most widely accepted conceptualization of economic interdependence is commercial openness, usually represented as the ratio of trade to total economic output (Oneal and Ray, 1997; Oneal and Russet, 1997). More specifically, an increasingly employed measure of dyadic dependence is the score of the state with the lower dependence level, which is often referred as the "weakest link" (Dixon, 1994). However, it is generally problematic to employ this method, partly because one state alone does not define a dyadic relationship, and also the weakest link approach could exacerbate the problem of biased sampling (Barbieri, 2003). Thus, we use the measure introduced by Barbieri (1996) which contains two dimensions of dyadic interdependence - the salience and the symmetry. The indicators used to capture

dependence are total-trade based. The share of trade is calculated as:

$$TradeShare_i = \frac{DyadicTrade_i}{TotalTrade_i}$$

where $i \in \{A, B\}$.

The trade shares are then used to calculate dyadic salience, which measures the dyadic level of dependence:

$$Salience_{AB} = \sqrt{TradeShare_A * TradeShare_B}$$

And symmetry is calculated as follow, indicating the equality of dependence:

$$Symmetry_{AB} = 1 - |TradeShare_A - TradeShare_B|$$

Finally, a measure of interdependence combines both the salience and symmetry.

$$Interdependence_{AB} = Salience * Symmetry$$

We also include the squared term of interdependence and military balance (the log of the ratio of the CINC index of the stronger to the weaker state) to examine whether the non-monotonic relation is caused by commercial dependence or other factors rather than simply by economic incentives.

Table 1.6 shows our results are generally robust after using terms which capture the effects of economic interdependence and other possible factors are considered. The positive impact of RE is significant in all columns as before, while the negative impact of its squared term is significant in most models except the last model, which is a conditional logit with year-fixed effects. The Hausman test is significant at 5% level, yet the auxiliary test for the unrelatedness assumption is not significant, thus we cannot tell whether fixed effects or random effects models are more appropriate.

Moreover, the null hypothesis that the coefficients for all year dummies are jointly equal to zero cannot be rejected in the case of the conditonal logit model, which implies that year-fixed effects may not be needed in this case. Hence, our main finding about the non-monotonic relation between relative wealth level and probability of war we found is indeed robust and not caused by other factors like economic interdependence.

In addition to that, what is different from previous findings is that if we include economic interdependence, the impact of joint democracy on war onset becomes ambiguous and insignificant in all columns. We also find a weak non-monotonic relation between the balance of military power and war, although it only appears in the non-fixed effects models. More importantly, the effect of interdependence on conflict escalation is negative rather than positive and significant in models (1), (3) and (5), which are without year-fixed effects, and the effect of its squared term is positive but only significant in the first three models. This indicates that the increase of the interdependence level may lower the possibility of conflict escalation between two countries, which is consistent with the previous findings of

the liberals.

Table 1.6 *Accounting for Omitted Variables (using the same data and models with baseline)*

	(1)	(2)	(3)	(4)	(5)	(6)
War	Pooled MLE APE	Pooled MLE APE	Random Effects APE	Random Effects APE	Fixed Effects Coefficient	Fixed Effects Coefficient
RE	0.0444***	0.0476***	0.0471***	0.0527***	0.366***	0.379**
	(0.00998)	(0.00971)	(0.0119)	(0.0111)	(0.122)	(0.169)
RE2	-0.00161***	-0.00181***	-0.00164***	-0.00195***	-0.0144**	-0.00957
	(0.000518)	(0.000483)	(0.000606)	(0.000538)	(0.00649)	(0.00878)
demdem	-0.0587	0.0316	-0.0755	0.0152	0.0158	-1.305
	(0.0439)	(0.0473)	(0.0537)	(0.0577)	(0.572)	(1.507)
MajorPower	-0.142***	-0.135***	-0.141***	-0.136**	-0.132	-38.46
	(0.0396)	(0.0453)	(0.0474)	(0.0540)	(0.898)	(5219.2)
Nonaggression	-0.00296	-0.00275	-0.0100	-0.00761	-0.966*	-0.795
	(0.0383)	(0.0384)	(0.0445)	(0.0449)	(0.514)	(0.915)
DirCon	0.0296	0.0895*	0.0296	0.102*	-0.676	2.731
	(0.0474)	(0.0488)	(0.0522)	(0.0572)	(1.086)	(2.084)
Lndist	0.0303	0.0525**	0.0319	0.0606**		
	(0.0224)	(0.0236)	(0.0262)	(0.0285)		
DiploEx	0.0165	0.0809	0.0184	0.0937	-0.0543	0.402
	(0.0437)	(0.0812)	(0.0467)	(0.0864)	(0.374)	(1.067)
MilitaryBalance	-0.0669*	-0.0634*	-0.0712*	-0.0678*	0.806	-1.769
	(0.0342)	(0.0352)	(0.0388)	(0.0403)	(0.602)	(1.325)
MilitaryBalance2	0.0155**	0.0134**	0.0159**	0.0137*	-0.0119	0.147
	(0.00658)	(0.00677)	(0.00732)	(0.00749)	(0.0960)	(0.186)
Interdependence	-2.656**	-2.013	-3.073**	-2.209	-29.07**	-23.22
	(1.113)	(1.288)	(1.401)	(1.510)	(14.50)	(30.01)
Interdependence2	16.37**	13.14*	19.13*	15.37	48.06	2.025
	(7.265)	(7.818)	(10.59)	(10.20)	(108.5)	(213.0)
Dyad fixed effects	no	no	no	no	yes	yes
Year fixed effects	no	yes	no	yes	no	yes
Observation	941	857	941	857	421	421
pseudo R^2	.047	.142	.045	.143	.093	.542
Log lik.	-580.3	-477.9	-577.1	-473.8	-146.4	-74.03
Chi-squared	50.89	139.9	39.89	121.5	30.15	174.9

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Reverse Causality

As suggested previously, war, whether external or internal, large or small, causes disruption of economic activities, loss of life and, especially, destruction of material possessions. The large and persistent impacts of wars on trade, national income, and global economic welfare have been studied and found to be empirically verifiable (Blomberg and Hess, 2012; Collier, 1999; Glick and Taylor, 2010). This implies a possible reverse causality between war and relative wealth.

Similarly, although many studies have focused on how the nature of a political regime could affect the likelihood of war, recently they have raised people's attention that whether a state is easily involved in conflicts also has an impact on the country's selection of regime type. These arguments include that more war may cause concentration of political power or even encourage dictatorship (Thompson, 1996); and higher peace levels provide a stable environment for democratization (Gates et al., 1996; Reiter, 2001).

If this is the case, the estimated coefficients will then be inconsistent due to the potential endogenous issue caused by this reverse causations. One way to solve this problem is to find instrumental variables (IV) that are correlated both with the suspected endogenous and the exogenous regressors (have no direct impact on conflict) after controlling for the effects of the other regressors. Since the dependent variable '*War*' is binary, there are generally two extensions of the Two-Stage Least Squares (2SLS) approach which are known as Two-Stage Residual Inclusion (2SRI) and Two-Stage Predictor Substitution (2SPR) (Terza et al., 2008). The first stages of both approaches are similar to 2SLS, where

endogenous variables are used as dependent variables in a reduced-form regression model with all exogenous variables, including IVs as explanatory variables. In the second stage of 2SPR, the predicted value is used in place of the original endogenous variables and logit regression is then used; while in the 2SRI, the residuals of the first-stage model are included in the logit model, as well as, the original endogenous regressors. Using 2SPR could be problematic because it produces biased standard errors. It has also been shown by Terza et al. that within a nonlinear regression framework the 2SRI estimator is generally consistent while the 2SPS approach is not. Beside the accuracy in estimation of standard errors, another advantage of the 2SRI procedure is that it allows for statistical testing of endogeneity. This can be easily done by using the t-statistic of the coefficient for the residual included in the second stage [11]. The 2SRI procedure is shown in the following equations:

$$\begin{aligned} &\text{First-stage Logit or OLS:} \quad X_2 = \mu_0 + X_1\mu_1 + Z\mu_2 + \varepsilon_2 \\ &\text{Second-stage Logit:} \quad Pr\{War_{AB,t} = 1\} = \gamma_0 + X_2\gamma_1 + X_1\gamma_2 + \hat{\varepsilon}_2\gamma_3 + \varepsilon_1 \end{aligned} \tag{1.6}$$

where the vector X_1 contains exogenous, observed factors, that influence the willingness and ability to escalate conflict among dyads (AB) at time (t): in this case we have Major Power, Non-aggression terms, Direct Contiguity, log of distance, Diplomatic Exchange and Military Balance. While vector X_2 contains the endogenous variables, thus $X_2 = (RE, RE2, demdem)$ [12]. Vector Z contains identified instruments. $\hat{\varepsilon}_2$ is the residuals

[11] The validity of the test does not depend on the normality or homoskedasticity of the error term according to Wooldridge (2002).

[12] Logit model for binary endogenous variable '*demdem*' and linear model for continuous endogenous variables '*RE*' and '*RE*2' in the first stage.

produced from the first stage and is included in the second stage using maximum likelihood.

To reduce issues of reverse causality in situations where regime transitions and disputes occur during the same year, Baliga et al. (2011) lag all explanatory variables by one period. As Cameron and Trivedi (2005, p106) discuss, use of a lagged value is a common strategy in application of IV to panel data. Following their idea, we then use the one-period and five-periods lags of related explanatory variables (RE_1, RE2_1, demdem_1, RE_5, RE2_5, demdem_5) as instrumental variables to perform a two-stage residuals inclusion for panel data. Table 1.7 shows the results of the first stage of 2SRI where we run reduced-form regressions on endogenous variables with all instruments and other exogenous variables [13]. The strength of the lags as instruments can be easily tested by examining their partial correlation with the endogenous regressors. It is measured by calculating the F-statistics of whether the coefficients of instruments are jointly zero after the first stage regression. And the F-test indicates that the instruments are indeed relevant. Also, the over-identification test [14] suggests our IVs are valid as they are not correlated with the error term (See Appendix A.4).

However, the standard errors of the estimates from 2SRI are not correct. So we used bootstrapping to approximate the asymptotically correct standard errors (ACSE) for the estimated coefficients. Table 1.8 shows the results of the second stage. After accounting for the issue of reverse causality, the *RE* is significant in the first four non-fixed effect

[13] The Hausman test for each model suggests a fixed effects model for the first stage.

[14] The over-identification test for panel data can only be performed after 'xtivreg' which is what we used here.

models and *RE2* is only significant in models (2) and (4). However, the coefficients of all three estimated residuals (v1-v3) are insignificant in the second stage, which indicates we do not identify endogenous features for *RE*, *RE2* and *demdem*. Therefore, estimation using instrumental variables techniques may not be necessary. This may due to the hysteretic nature of the impacts of wars on both domestic economic and political environment.

Table 1.7 *The First Stage of 2SRI (using the same data and models with baseline)*

	(1)	(2)	(3)
Dependent	RE	RE2	demdem
	Coefficient	Coefficient	APE
RE_1	0.884***	-4.849*	0.0236**
	(0.0990)	(2.521)	(0.0110)
RE2_1	-0.000613	1.085***	-0.00257**
	(0.00844)	(0.233)	(0.00107)
demdem_1	0.0141	0.822	0.0721***
	(0.0574)	(1.152)	(0.0168)
RE2_5	0.154*	5.979**	-0.0215**
	(0.0890)	(2.316)	(0.00982)
RE_5	-0.00270	-0.179	0.00170**
	(0.00743)	(0.221)	(0.000670)
demdem_5	-0.0113	-1.054	0.00831
	(0.102)	(2.212)	(0.0108)
MajorPower	0.248	7.393	-0.00353
	(0.398)	(9.050)	(0.00572)
Nonaggression	0.109	1.944	-0.000843
	(0.0991)	(2.221)	(0.00650)
DirCon	-0.0768	-2.728	0.0105
	(0.0996)	(2.575)	(0.00850)
Lndist			0.00318
			(0.00380)
DiploEx	-0.0407	-0.590	0.000233
	(0.0293)	(0.664)	(0.00374)
MilitaryBalance	-0.115	-3.479	0.0000146
	(0.106)	(2.492)	(0.00124)
_cons	0.257	8.463*	
	(0.224)	(5.070)	
Observation	1144	1144	1133
(pseudo) R^2	0.938	0.886	0.873
F-statistics	916.53	296.80	119.60

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.8 *The Second Stage of 2SRI (using the same data and models with baseline)*

	(1)	(2)	(3)	(4)	(5)	(6)
War	Pooled MLE	Pooled MLE	Random Effects	Random Effects	Fixed Effects	Fixed Effects
	APE	APE	APE	APE	Coefficient	Coefficient
RE	0.0370***	0.0502***	0.0411***	0.0553***	0.331*	0.386
	(0.0122)	(0.00827)	(0.0155)	(0.0109)	(0.171)	(0.510)
RE2	-0.00119	-0.00179***	-0.00125	-0.00188**	-0.0124	-0.0150
	(0.000790)	(0.000590)	(0.000949)	(0.000764)	(0.0107)	(0.0703)
demdem	-0.0613	0.0447	-0.0943	0.0207	-0.939	-2.715
	(0.0544)	(0.0375)	(0.0677)	(0.0978)	(4.749)	(13.13)
MajorPower	-0.101***	-0.0977*	-0.102**	-0.103**	-0.502	-0.362
	(0.0380)	(0.0565)	(0.0475)	(0.0418)	(6.503)	(19.36)
Nonaggression	-0.0372	-0.0325*	-0.0505	-0.0333	-1.146	-1.316
	(0.0370)	(0.0196)	(0.0431)	(0.0480)	(0.980)	(7.244)
DirCon	-0.0432	-0.00613	-0.0341	0.00616	0.383	1.169
	(0.0445)	(0.0539)	(0.0489)	(0.0420)	(2.562)	(9.582)
Lndist	-0.000678	-0.000111	0.00954	0.0133		
	(0.0196)	(0.0279)	(0.0230)	(0.0212)		
DiploEx	0.0127	0.0425	0.0145	0.0596	0.0898	0.492
	(0.0394)	(0.0769)	(0.0423)	(0.0520)	(0.384)	(0.724)
MilitaryBalance	0.0359***	0.0294***	0.0394***	0.0305**	0.745**	0.224
	(0.0120)	(0.0106)	(0.0141)	(0.0134)	(0.371)	(0.990)
v1	0.0672	0.0493	0.0814	0.0689	0.918	0.717
	(0.0785)	(0.0626)	(0.0929)	(0.0512)	(0.906)	(2.213)
v2	-0.00350	-0.00242	-0.00429	-0.00330	-0.0341	-0.0230
	(0.00342)	(0.00284)	(0.00391)	(0.00344)	(0.0405)	(0.255)
v3	-0.00571	-0.0157	-0.00302	-0.0132	0.154	0.393
	(0.0158)	(0.0144)	(0.0190)	(0.0221)	(0.862)	(2.615)
Observation	1128	1093	1128	1128	3768	3768
pseudo R^2	0.033	0.119	0.034	0.122	0.063	.361
Log lik.	-681.36	-608.31	-673.29	-598.39	-170.22	-74.03

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

To summarize, we obtain consistent estimations by considering endogeneity, such as reverse causality and omitted variables. The proposition that the probability of conflict

escalation first increases with the increase of relative wealth level and then decreases once the relative wealth exceeds a certain level is verified. Thus, it implies that economic motives, such as acquiring resources, originally have a positive impact on the onset of war, but that this impact is offset completely by the fear of being defeated when facing an extremely powerful target.

1.5 Conclusion

We know economic factors play an important role in the outbreak of militarized conflict. The key variables of levels of economic and social welfare are not given enough attention in the study of inter-state war. Therefore, we believe it is necessary to explore the economic causes of war in order to have better understanding of why war occurs.

Built on the argument that armed conflict is a consequence of failed inter-state bargaining, and to link economic ties between nations to the bargaining process, we set up a basic two-country bargaining model. The economic analysis indicates that with perfect information there are two kinds of equilibria in neither of which should war occur: one is that when the aggressive state does not have a large enough chance of winning, it will never choose to go to war, reasoning that the targeted state will reject any proposals so that no settlement is accessible, whereas no further moves could be made by the aggressor; the other, in contrast, is that even when the probability of victory for the aggressor is large enough, the expected gains from war would still be lower than what it can get from concessions, thus no war

would be initiated. On the other hand, the model with non-transferable benefits, provides an explanation for what could cause the occurrence of war. This features a situation in which a target state values its own possessions more than what actually can be expropriated by the aggressor, and so reduces the amount of proposals that the target state is willing to accept. For the aggressor, that creates potential net profits through the use of violence, and as a result makes war more likely.

Further discussion about the condition of war occurrence suggests the non-monotone effect of relative wealth level (wealth of targeted country/ wealth of aggressive country) on the probability of war initiation. The empirical estimations confirm this finding, and thus provide some insight into how economic motives affect states' incentives for war. By using different empirical models, different methods of measurement, and taking endogeneity issues into account, it is shown that the results are robust. We find that the targeted state is more likely to compromise when facing a stronger enemy, and economic factors, especially nation wealth, can have complex effects on both countries' intentions of going to war.

Generally speaking, the resolve of the initiator in a dispute increases with the wealth of the targeted country when the relative wealth does not exceed a certain level. This critical level is found to be very high and only very few dyads in MID data have relative wealth higher than this level (23 out of 1,489 observations using Maddison; 3 out of 831 observations using PWT). As a result, we observe conflict escalation between two countries with a huge power gap, such as the Kosovo War in 1999 and the First Gulf War in 1991. In none of these conflicts was the US the initiator of the disputes, however, the US still

decided to go to war in the end, which disproves the argument that rich states are less war-prone because they have more to lose. Rich states could also tend to fight once they expect more from war than non-violent way.

Chapter 2

Understanding Democratic Peace: Game-theoretical Analysis of Political Regime and Asymmetric Information

Abstract

This chapter builds a model to analyse the relationship between democracy and peace found in previous empirical studies. The model employs a theory of bargaining. A two-country conflict model with possible choices between a pre-war negotiated settlement and war is built. The basic bargaining model is extended by introducing political regime type and asymmetric information. The difference of structural feature between political regimes affects the rulers' incentives of making decisions about war. Our model suggests under perfect information, autocratic leaders cannot make extra profit from going to war; with information asymmetry, weak aggressor will never be better off by starting a war and democratic peace is only valid under certain condition.

Key words: Conflict, Bargaining, Political Regime

2.1 Introduction

Since the 1980s many studies that try to explore international relations have focused on the influence of the political regime type. More specifically, they try to investigate the relation between different political regimes and their international behaviours, especially their conflict involvement. However, the empirical findings on this problem are mixed. Some studies find no relationship between political regime type and war proneness, while others find an inverse relationship between democratic level and the probability of international conflict involvement. The most widely recognized result of this research question is called "democratic peace".

"Democratic peace" is an empirically well-studied phenomenon in international relations. It has been shown that democracies rarely go to war with each other (Maoz and Abdolali, 1989; Rummel, 1995; Starr, 1997). However, other research suggests that, in general, a democracy is no less war-prone than any other regime type (Gleditsch and Hegre, 1997; Rousseau et al., 1996). Hence, there arise the questions whether "democratic peace" truly implies a causality between democracy and the absence of war, and why it only applies at dyadic level. If we consider the possibility that there are other factors that facilitate the establishment of democracy and reduce the possibility of war at the same time, then "democratic peace" may be able to be explained in another way, rather than by a causal relationship between democracy and peace.

One of the possible factors is economic performance. Many studies suggest connections

between democracy and economic development (Barro, 1996; De Haan and Siermann, 1996; Gerring et al., 2005; Helliwell, 1994; Heo and Tan, 2001). In addition, a country's economic situation has great impact on its military capacity, and thus affects its decision to go to war. Economic considerations play an important role in studying the occurrence of war. Therefore, we follow the same bargaining structure in Chapter 1 and discuss the question whether theoretical analysis supports the plausible relationship between democracy and peace at dyadic level. We argue that democratic peace only exists under certain conditions.

A two-country conflict model with possible choices between a pre-war negotiated settlement and war was built. The basic bargaining model is extended by introducing political regime type and asymmetric information. The ruler in each country maximizes a linear combination of public's welfare and the value of staying in power (rent from office). The ruler in a democracy needs to consider the probability of losing the office in a post-war re-election. An autocratic government, who generally consists of a small and influential elite, is assumed to have no risk of losing the office and thus will get the rent for sure. This structural feature affects the ruler's incentives for making decisions about war, which, leads us to the conclusions: autocratic leaders cannot make extra profit from going to war, but democratic leaders can, because their chance of survival at re-election might increase due to a favourable outcome of conflict; a democracy with high expectation on the probability of victory in war is more aggressive than an equivalent autocracy.

The chapter is structured as follow: Section 2.2 reviews related literature. Empirical

studies show that on the one hand fewer wars are observed between democracies; on the other hand, democracy is not more peaceful at the state level. Other theoretical works intend to explain how the electoral mechanism in democratic regimes can affect leaders' behaviour on deciding whether to get involved in war, although the fact is that the impact of electoral incentives on the decision to go to war is not straightforward. Also, it has been noticed that rather than regime type it could be economic structure that causes the rare fighting observed between democracies (Maoz and Russett, 1993). Section 2.3 introduces political regime type into the model. The theoretical analysis suggests that, under conditions of perfect information, conflict escalation is only possible when at least one democracy is involved, because autocratic leaders have no incentives for going to war. In other words, we shouldn't observe war between autocracies at all. Yet, this apparently contradicts the empirical evidence. Therefore, another extension would be to incorporate the issue of information asymmetry.

In section 2.4, the models with asymmetric information consider two situations where either the initiator or the target in the conflict is of two possible types: high or low, categorized by military proficiency. A different level of military proficiency is directly related to the probability of victory once war is initiated. While it has access to information about its own type, neither side knows the type of the other side. We reach two conclusions. Firstly, a low-type initiator in the dispute will never be better off by starting a war. Secondly, if a democratic initiator is high type and its probability of victory is big enough, the ruler's expected payoff from going to war exceeds the payoff of a peaceful settlement. In this case, democracy would be more aggressive than autocracy. Conversely, if the probability

of victory is small, a democracy would be less war-prone compared with an autocracy. Hence, we argue that the concept of democratic peace is only true when a democracy has low expectations of its probability of victory. Section 2.5 is the conclusion.

2.2 Literature Review

Maoz and Abdolali (1989) empirically study the relations between regime type and conflict involvement of states. Using two comprehensive datasets on polity characteristics and militarized interstate disputes, they perform a dyadic analyses which requires breakdown of each dispute into all of its initiator-target dyads. Their empirical findings are: there is a significant relationship between the regime characteristics of a dyad and the probability of conflict involvement of that dyad - Democracies rarely clash with one another, and never fight one another in war; however, there is no relation between regime type and conflict involvement measures when the unit of analysis is the individual polity. These empirical findings are well-known as "democratic peace", which suggests that democracies, unlike autocracies, very rarely fight each other.

Different political regimes depend on different ways in which leaders come to power, and therefore the incentives for making decisions about war. This idea has already been well demonstrated in a classic work by Kant (1795). Thus, one common explanation for democratic peace that has been pointed out is the structural features of democratic regimes. In particular, it denotes that the political mobilization processes in democratic systems enforce institutional constraints on the leaders when facing each other so that

violent conflict becomes infeasible (Maoz and Russett, 1993).

For example, Conconi et al. (2008) set up a game-theoretic model to examine the effect of electoral incentives on the decision to make war and shows that the fear of losing office can deter democratic leaders from engaging in military conflicts. However one of the bases in this model, that voters on both sides reward peaceful behaviour and punish aggressive behaviour is not always plausible. Thus the conclusion that, democratic countries are more likely to show the constraint that prevent leader from starting a war than other types of dyads, may not necessarily be true. The paper also analyses the data from 1816 to 2001 on countries with executive term limits and finds that democratic dyads are in general less likely to be involved in conflicts than any other dyads; however, this result does not hold for democracies in which the executive faces binding term limits.

A similar work by Baliga et al. (2011) investigate the same problem about how electoral incentives may affect leaders' behaviour on war. A simple Schelling's dilemma model, where aggression can be triggered by domestic political concerns as well as the fear of being attacked, is set up to find out the constraints under which countries will choose an aggressive strategy, so that each country's possibility of doing so is shown. What's worth noticing is that Baliga et al. find a non-monotonic relationship between democracy and peace. To be specific, in contrast with other works on democracy and peace which believe the democracy dyad is less war prone; they claim that a dyad of limited democracies is more likely to be involved in a militarized dispute than any other dyad. They analyse the Correlates of War data for the period 1816 - 2000 and find the results do support their

statement. Another interesting finding is that as the environment becomes more hostile, fully democratic countries become more aggressive faster than other regime types.

In addition to structural causes, other possible reasons for democratic peace, normative causes or so-called cultural explanations, argue that norms of compromise and cooperation predispose democracies toward peaceful relations, hence democratic citizenry discourage the use of militarized force, and prefer to resolve conflicts by peaceful means like negotiation.

Jackson and Morelli (2007) have provided some insight into this normative feature of democracy. They introduce the concept of 'political bias' which is measured by the ratio of the share of benefits from war compared to the share of costs for the leader, and compared to that of the country in mass. If a leader's risk/reward ratio from a war is the same as that of the whole country, then he is said to be politically unbiased. Jackson and Morelli point out that when both two countries are politically unbiased and the commitment to transfer are feasible and credible, they will never go to war. Their results, to some extent, explain the phenomenon of democratic peace based on the hypothesis that democracies are less biased. But they also predict two sufficiently biased democracies could still go to war with each other, which leads to an important conclusion: it is not democracy but absence of political bias which is the key determinant of peace. Furthermore, assuming political bias can be endogenous, it has been found that sometimes the presence of transfers provides incentives for countries to choose leaders with high bias, since a more hawkish policy may gain them a more advantageous position in bargaining, and so benefit their citizens.

Jackson and Morelli's finding implies that the incentive to leaders of staying in the office, in turn, may affect their hawkishness, and thus their decision on starting a war. However, this effect can be complicated. Hess and Orphanides (1995, 2001) show that an incumbent leader may tend to initiate a war to reveal his capability to control one, and so improve his probability of winning the re-election when facing poor economic performance. In the model they divide public welfare into two parts: the incumbent leader's ability to manage the economy and his war handling ability. To verify that some conflicts are potentially avoidable, as predicted by the model, they indicate that the observed frequency of war is higher compared to other periods when economic performance is unfavourable, and the incumbent leaders are facing re-election.

Maoz and Russett (1993) mention another potential explanation for democratic peace. They point out that it could be the economic structure rather than the type of political regime that leads to the relatively peaceful status between democracies. Rich countries are less likely to fight with each other because they may lose more than what they can gain from war. And most democracies in the post-World War II era have been economically developed states (Gerring et al., 2005; Helliwell, 1994; Przeworski and Limongi, 1993). Further, democracies are more open and rich, hence often engaged in heavy trading with each other. As a result, getting involved in war can causes democracies huge costs, and the costs may outweigh the benefits of doing so. The empirical results do show a significant negative effect of wealth and growth rate on dyadic conflict involvement and escalation, which potentially confounds the relationship between democracy and peace.

The causes of war have been categorized by Jackson and Morelli (2011) in two ways: failure in bargaining, and circumstances when the expected benefits from war outweigh the costs for at least one of the sides. Thus, they indicate that, to understand the reasons for wars, the main tasks are to investigate why bargaining fails, and in what circumstances the expected benefits from war outweigh the costs for at least one of the sides, although we believe the two conditions are related in most cases. They then list a few possible causes of bargaining failure. In those various situations, the problem of asymmetric information is one the main reasons why bargaining might fail. Asymmetries of information can be caused by different sources. It could be that agents do not have correct beliefs or information about each other. It could also be that agents cannot gather accurate information about the potential outcome of war. It has also become a very important aspect in most literature about conflicts. In addition, Jackson and Morelli provide a broader definition of rational behaviour that does not require the agent's payoff to correspond to the payoff the state or country that agent is the representative of. In other words, the rulers of countries might take less risks or gain greater profits or glory from war than their citizens, which reveals a new understanding of the realm of rationality.

Levy and Razin (2004) have shed some light on theoretical analysis of democratic peace. A conflict resolution model is established on the basis of asymmetric information and strategic complements. Because countries usually are not aware of the preferences of their rivals, and political leaders may gain more information than the general public, a communication stage for leaders is set up to transmit messages about their own countries' cost-benefit ratio

to both the general public of their own countries and the rival. The difference between democracies and autocracies is that, in a democracy, the leader transmits information, and the public make decisions according to that information; however, it is only the leader who makes the decisions in an autocracy. One important assumption in Levy and Razin's model is that mutual concession is the most favourable result, and so the concessions exhibit strategic complements. They discuss how the strategic interaction between two democracies differs from that of other dyads, and find that two democracies have the highest probability of resolving their conflict peacefully. However, a mixed dyad that involves only one democracy does not appear to be more peaceful than a non-democratic dyad. Hence they conclude that it takes two democracies for peace. However, their conclusion becomes weaker when the conflict described in the model does not concern strategic complements but substitutes. In other words, if it is possible that for both countries to concede is not optimal (since one may gain benefit from winning the war), the previous conclusion that two democracies induce the highest probability of a peaceful resolution only holds under more strict conditions.

As has been well demonstrated in previous studies, structural causes are widely accepted as a common explanation of democratic peace. It generally assumes that citizenry preferences are exogenous and the citizenry of a democracy are generally less war-prone. However, it should be questioned whether this assumption is realistic, as war propaganda is likely to manipulate constituent preferences. Nevertheless, both structural causes and normative causes fail to explain why this peace phenomenon only appears within democracies but when they are facing other regime types the so-called peace-loving feature does not work so well.

Therefore, we expect considering economic structure as a key factor when discussing what is more important in causing war initiation can give a new explanation for democratic peace.

2.3 Model with Political Regime

We follow the basic bargaining model in Chapter 1 to study how decisions on war are related to states' regime type. Recall that there are two countries in the game, country A and country B, each with initial endowment W_A and W_B. First, country A proposes an amount of 'S' that is part of initial wealth endowment of country B to be given up by country B, $0 < S \leq W_B$. Then country B can decide whether to accept or reject the proposal. If country B accepts, country A gets 'S' and B loses 'S', so the total payoff vector is $(W_A + S, W_B - S)$.

If country B chooses to reject, then country A makes a decision on whether to start a war or not. If country A decides to quit, both countries maintain their endowments, the payoff vector is represented as (W_A, W_B). If country A chooses to start a war, then with a probability P_A country A will win the war. If country A wins, it gets a transfer T_B from country B. Otherwise, country A loses the war so B gets a transfer T_A from country A. Both countries pay a cost $C = (C_A, C_B)$ when war happens.

In order to introduce different regime types, we assume it is the ruler in each coun-

try, instead of country itself, that is making decision about whether to initiate a war [1]. The ruler's value of staying in power is the rent from office, denoted R. In a democracy, the ruler will have to go through re-election after the current term of office. The autocratic selectorate, however, generally consists of a small and influential elite. Hence, the power base of the selected autocrat differs substantially from that of a democratic leader. Consequently, the ability and incentives to replace a leader vary across regimes (Tangerås, 2009). For simplicity, the autocratic ruler is assumed to have no risk of losing the office in our model and thus will get the rent for sure.

We assume the rulers maximize a linear combination of their rent (R) and the public's welfare as Hess and Orphanides (2001). Then a leader's utility function is

$$U_i^k = (1-\alpha_i)V_i^k + \alpha_i Q_i^k R \qquad i \in \{A,B\} \quad \text{and} \quad k \in \{L,Q,W,D\}$$

where α_i is a measure of a leader's selfishness, which is the weight he places on the rents from being in office rather than the public's welfare. V_i^k is the public's total welfare, that is, the wealth level in this model with outcome k. $\{L,Q,W,D\}$ represent four different outcomes respectively:

L: country B accepts the proposal;

Q: country A quits after being rejected;

W: country A wins after war occurs;

[1] For another study of relationship between conflict and political leadership, please see Bandyopadhyay and Oak (2011).

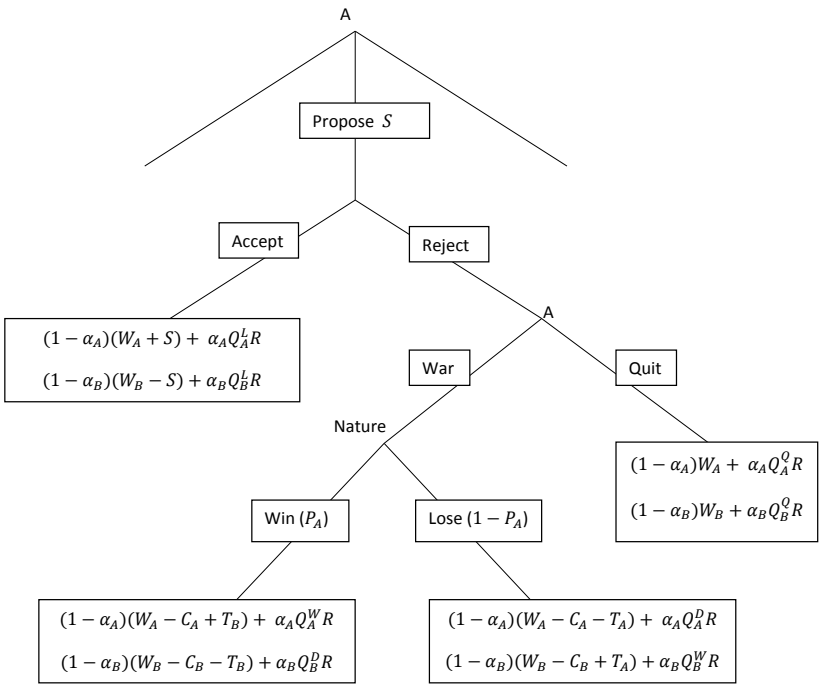
D: country A loses after war occurs.

Q_i is the probability of re-election with outcome k. For a democratic ruler, $Q_i \in \{Q_i^L, Q_i^Q, Q_i^W, Q_i^D\}$. For an autocratic ruler, $Q_i = 1$.

2.3.1 Democracy vs. Democracy

If both country A and B are democratic, the basic model can be extended as

Figure. 2.1 *Bargaining Model between Two Democracies*



By solving the game backward, we are able to identify the the maximum that country B will accept, S^* (See Appendix B.1). Now we consider country A's payoffs between

proposing exactly S^* to avoid war or proposing more to start a war

$$E_A(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A Q_A^L R$$

$$E_A(War) = P_A * U_A(Win) + (1-P_A) * U_A(Lose)$$

where $U_A(Win)$ and $U_A(Lose)$ are country A's utilities when it wins or loses the war respectively. Thus

$$U_A(Win) = (1-\alpha_A)(W_A - C_A + T_B) + \alpha_A Q_A^W R$$

$$U_A(Lose) = (1-\alpha_A)(W_A - C_A - T_A) + \alpha_A Q_A^D R$$

If the payoff from proposing S^* is less than its expected payoff from war: $E_A(S^*) < E_A(War)$, we would expect war to happen. We solve and have the condition for initiation of war

$$C_A + C_B < \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A Q_A^W + (1-P_A)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\} + \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A)Q_B^W + P_A Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\} \tag{2.1}$$

The first term of right hand side of (2.1) can be seen as the weighted rents margin of the leader in country A (initiator) between starting a war and making an acceptable proposal, and similarly the second term would then be the weighted rents margin of the leader in country B (target) between getting involved in a war and accepting the proposal. We can summarize the condition as below:

Proposition 2.1. *When both countries are democracies, if both leaders can profit more from war than the costs of war, we would expect them to choose to go to war rather than reaching agreement.*

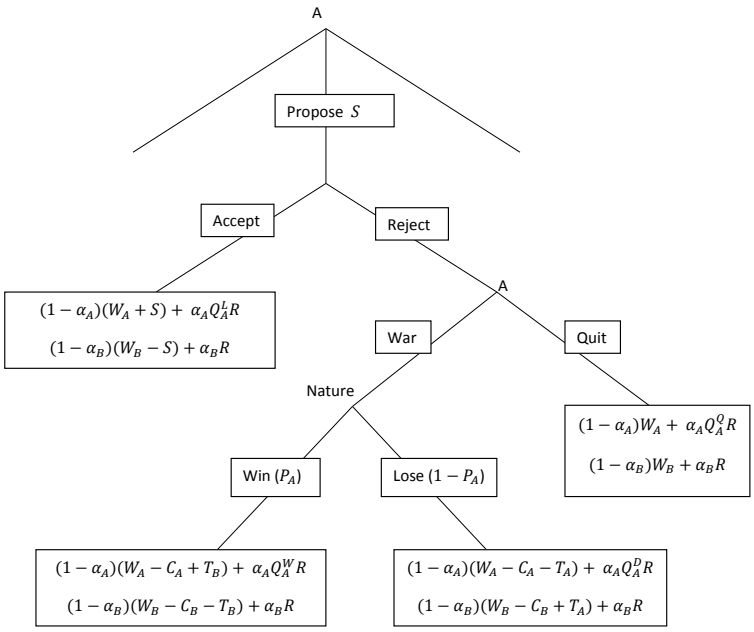
Remark. This result is similar to the results in the first chapter. The difference is that we allow the benefit from war for the democratic leaders through re-election. Condition (2.1) reflects both countries' incentives of going to war. The initiator has to consider not just its own costs and rent margins but also the costs and rent margins of the target country as they determine the equilibrium reaction of the target country (the costs and rent margin of the target country are considered when the initiator tries to make a proposal).

2.3.2 Democracy vs. Autocracy

Country A is Democracy

In an autocracy, the leader will stay in power no matter what happens, including peace and war, victory or defeat. Hence the leader's incentive of seeking for rent has no effect on making war decisions. When country A is democratic and country B is autocratic, the extensive form of the game is shown in Figure 2.2.

Figure. 2.2 *Bargaining Model between Democracy and Autocracy*



Again, we can identify the maximum that country B will accept, S^* (See Appendix B.2). If we compare country A's payoffs $E_A(S^*)$ and $E_A(War)$, we can solve and have the condition for initiation of war

$$C_A + C_B < \frac{\alpha_A}{1-\alpha_A}\{[P_A Q_A^W + (1-P_A)Q_A^D]R - Q_A^L R\} \tag{2.2}$$

When the targeted country is an autocracy, we can see the right hand side of above inequality is the first term of that in (2.1) and the second term that the weighted rent margin for the leader in country B becomes zero. This is because autocratic leaders will always get their rents no matter what the outcome is.

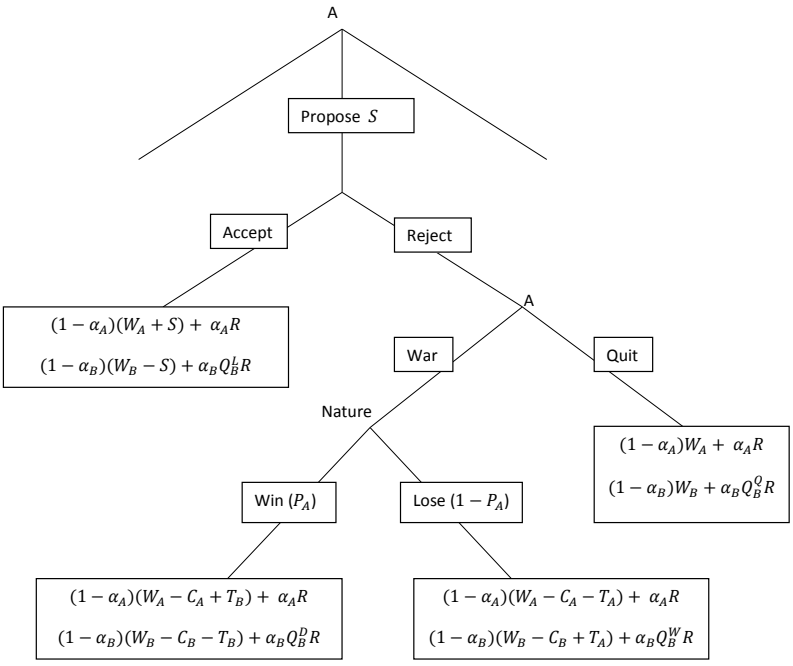
Proposition 2.2. *When the initiator is democracy and the target is autocracy, as long as the profit of democratic leader (initiator) outweigh the costs of war for both countries, we would expect the war to happen.*

Condition (2.2) also reflects both countries' incentives of going to war. Again, the initiator has to consider both countries' costs and rent margins but the rent margin for the leader in target country is zero in this case.

Country B is Democracy

When country A is autocratic and country B is democratic, the extensive form is shown in Figure 2.3.

Figure. 2.3 *Bargaining Model between Autocracy and Democracy*



If we compare country A's payoffs from proposing S^* (See Appendix B.3) and war: $E_A(S^*)$ and $E_A(War)$, we can solve and get the condition for war

$$C_A + C_B < \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A)Q_B^W + P_A Q_B^D]R - Q_B^L R\} \tag{2.3}$$

Similarly, if the initiator is autocracy, the weighted margin for the leader in country A is zero.

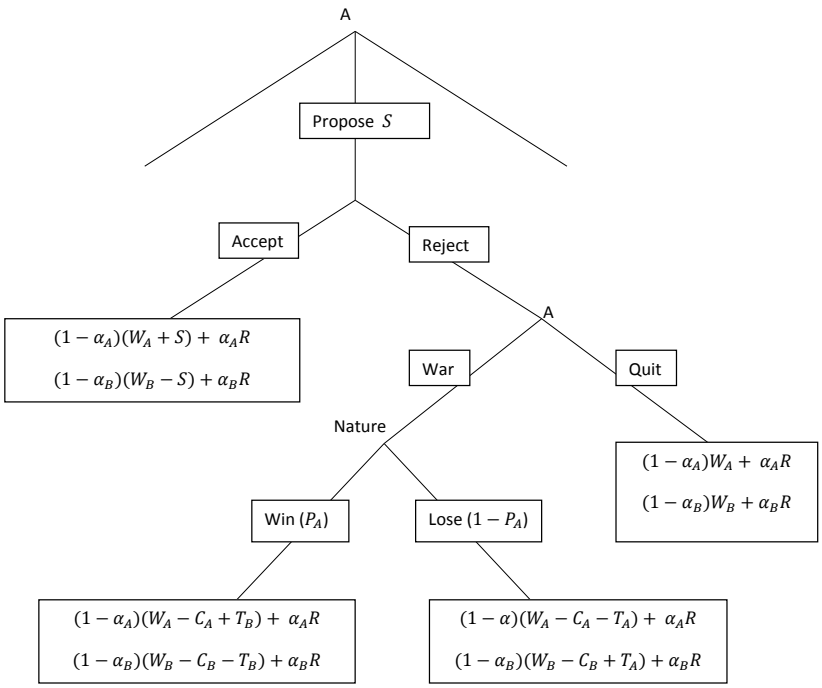
Proposition 2.3. *When the initiator is autocracy and the target is democracy, as long as the profit of democratic leader (target) outweigh the costs of war for both countries, we would expect the war to happen.*

Condition (2.3) also reflects both countries' incentives of going to war. Similarly, the initiator country has to consider both countries' costs and rent margins but the rent margin for the leader in initiator is zero in this case

2.3.3 Autocracy vs. Autocracy

When both countries are autocracies, the extensive form becomes:

Figure. 2.4 *Bargaining Model between Two Autocracies*



If we compare country A's payoffs from proposing S^* (See Appendix B.4) and war: $E_A(S^*)$ and $E_A(War)$, we can solve and get the condition for war

$$C_A + C_B < 0 \tag{2.4}$$

Compared with inequality (2.1), the weighted rent margins for both leaders become zero. This condition cannot be satisfied in reality, in other words, no war should happen in this case.

Proposition 2.4. *When both countries are autocracies, the condition for war can not be satisfied as the rent margins for autocratic leaders are always zero.*

Remark. With perfect information, autocratic leaders cannot make extra profit from going to war, which may imply no mutually beneficial agreement that avoids war exists. Condition (2.4) also reflects both countries' incentives of going to war where the rent margins for the leaders in both countries are zero.

According to the definition, leaders care about both social welfare and their own rents, and only democratic leaders have to consider the probability of losing office, which leads to the differences of rent margins from the decisions. If we compare conditions (2.1)-(2.4) we can see that it is the positive rent margin that democratic leaders can get from choosing war instead of peaceful settlement that makes the onset of war possible.

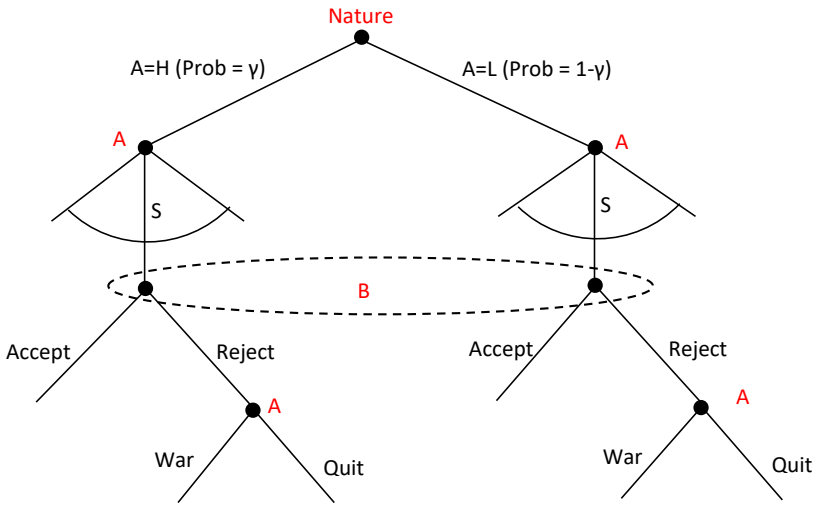
2.4 Model with Asymmetric Information

The two equilibria in the basic model of chapter 1 are characterized by P_A (probability that country A wins the war), which is highly related to the military capabilities of both two countries. We now consider the two models with asymmetric information where either the initiator or the target in the conflict is of two possible types: high or low, categorized by military proficiency.

2.4.1 Only Country A Has Types

Suppose the initiator (country A) has two types: high capability (with probability γ) or low capability (with probability 1-γ). Country A knows its own type but country B doesn't. Corresponding with high type and low type, the probabilities that country A wins the war are P_A^H and P_A^L respectively, $P_A^H > P_A^L$ (stronger military capacity increases country A's winning probability).

Figure. 2.5 *Game Tree when Country A has Private Information*



Types: Country A=H/L (High/Low)

Players: N → Nature; A → Country A; B → Country B

Actions: $\{S; \text{War}, \text{Quit}\}_A$; $\{Accept, Reject\}_B$

The game becomes: first, nature decides the type of country A; then country A can make a proposal *S* knowing its own type. When country B chooses between accepting or rejecting the proposal, it doesn't know country A's type. If the proposal is rejected, country A decides whether to quit the bargaining or go to war.

In order to identify equilibria, we need to compare P_A^H and P_A^L with $\frac{C_A+T_A}{T_A+T_B}$ (the value that decides whether country A would choose to go to war after being rejected, see chapter 1), hence there are three cases we need to discuss:

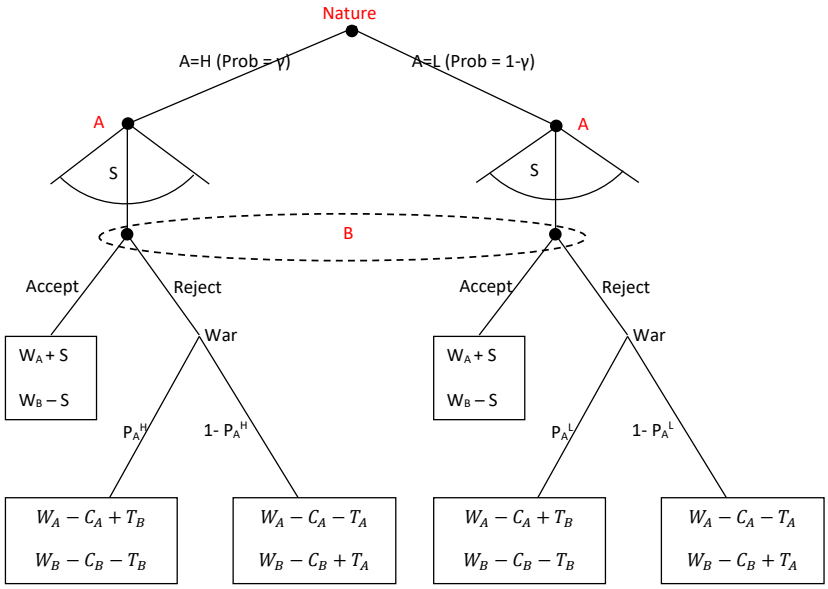
Definition 2.1. *We define the conditions for country A to go to war based as follow:*

- $\frac{C_A+T_A}{T_A+T_B} < P_A^L < P_A^H$*: both high-type and low-type country A will choose to go to war after being rejected;*
- $P_A^L < \frac{C_A+T_A}{T_A+T_B} < P_A^H$*: high-type country A will choose to go to war after being rejected and low-type country A will choose to quit the bargaining after being rejected;*
- $P_A^L < P_A^H < \frac{C_A+T_A}{T_A+T_B}$*: both high-type and low-type country A will choose to quit the bargaining after being rejected.*

a. When country A will always choose war ($\frac{C_A+T_A}{T_A+T_B} < P_A^L < P_A^H$)

In this case, country A will always choose to go to war after being rejected. The game can then be simplified as follow.

Figure. 2.6 *Simplified Form When Country A Will Always Choose War*



i. Actions of Country B

In this case, the payoff of playing strategy *Accept* for country B would be

$$E_B(Accept) = W_B - S$$

and the expected payoff of playing strategy *Reject* is

$$E_B(Reject) = \gamma E_B^H(War) + (1-\gamma)E_B^L(War)$$

$$= \gamma[W_B + T_A - C_B - P_A^H(T_A + T_B)] + (1-\gamma)[W_B + T_A - C_B - P_A^L(T_A + T_B)]$$

When $E_B(Accept) \geq E_B(Reject)$, country B will choose *Accept*. We have

$$S \leq C_B - T_A + [\gamma P_A^H + (1-\gamma)P_A^L](T_A + T_B)$$

So the maximum amount country B will accept is

$$S^* = C_B - T_A + [\gamma P_A^H + (1-\gamma)P_A^L](T_A + T_B)$$

ii. Actions of Country A

Country A will only propose either: S^* or any amount which is bigger than S^* (denoted as $> S^*$). This is because, for country A, any proposal smaller than S^* will definitely be accepted by country B and thus is worse than S^*; and any proposal which is bigger than S^* will cause war for sure. Therefore, country A has two strategies: S=$\{S^*, > S^*\}$.

If country A is High type, as long as its expected payoff from war is bigger or at least equal to the payoff from proposing S^*:

$$E_A^H(> S^*) \geq E_A^H(S^*)$$

it will prefer B to reject its proposal and then goes to war. Hence we have:

$$P_A^H(W_A - C_A + T_B) + (1 - P_A^H)(W_A - C_A - T_A) \geq W_A + S^*$$

Rearrange it, we have the condition of war

$$\gamma \leq 1 - \frac{C_A + C_B}{(P_A^H - P_A^L)(T_A + T_B)}$$

When above inequality is satisfied, country A will make a proposal which is bigger than S^* to let war happen. Otherwise, it will propose exactly S^* and country B will accept it.

If country A is Low type, we can prove getting involved into war is never better than proposing exactly $S^* : E_A^L(> S^*) < E_A^L(S^*)$, hence its best strategy is to propose S^*. Since country B is willing accept it, no war will occur.

iii. Combine with political regime

If we apply above analysis to the model with political regime, we can get the conditions of war for each different regime dyads (See Appendix B.5):

Democracy vs. Democracy:

$$\gamma \leq 1 - \frac{C_A + C_B - X - Y}{(P_A^H - P_A^L)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]} \qquad (= DD)$$

Autocracy vs. Autocracy:

$$\gamma \leq 1 - \frac{C_A + C_B}{(P_A^H - P_A^L)(T_A + T_B)} \qquad (= AA)$$

Democracy vs. Autocracy:

$$\gamma \leq 1 - \frac{C_A + C_B - X}{(P_A^H - P_A^L)(T_A + T_B)} \qquad (= DA)$$

Autocracy vs. Democracy:

$$\gamma \leq 1 - \frac{C_A + C_B - Y}{(P_A^H - P_A^L)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]} \qquad (= AD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

X is exactly the first term of right hand side of (2.1), which can be seen as the weighted rents margin of the leader in country A (initiator) between starting a war and making an acceptable proposal, and Y is the second term of right hand side of (2.1), which can be seen as the weighted rents margin of the leader in country B (target) between getting involved in a war and accepting the proposal.

To compare the four conditions, we assume the right hand side of above four conditions to be 'DD', 'AA', 'DA' and 'AD' respectively. We can get the relationships of the magnitude as follow:

If $X < 0$, the leader of a democratic initiator gets less from starting a war than making an

acceptable proposal, then

$$DA < AA \quad DD < AD \qquad ①$$

If $X \geq 0$, the leader of a democratic initiator gets more or at least equal from starting a war than making an acceptable proposal, then

$$AA \leq DA \quad AD \leq DD \qquad ②$$

If $Y > 0$, the leader of a democratic targeted country gets more from getting involved in a war than accepting the proposal, then

$$DA \leq DD \quad AA \leq AD \qquad ③$$

Now let's consider what these relationships tell us. If the right hand side is bigger, that means the interval for γ to lie between is bigger. In other words, the condition for the initiation of war is more likely to be satisfied, which implies the war is more likely to happen. If $X < 0$, we can see from ① that, no matter whether the targeted country is a democracy or an autocracy, the autocratic attacker is always more likely to start a war; or vice versa. If $Y > 0$, we can see from ③ that, no matter whether the attacker is a democracy or an autocracy, the autocracy is always more likely to be the target, although we can't get

the opposite when $Y \leq 0$. Notice that

$$X < 0 \quad \text{when} \quad P_A^H < \frac{Q_A^L - Q_A^D}{Q_A^W - Q_A^D}$$
$$Y > 0 \quad \text{when} \quad P_A^H < \frac{Q_B^W - Q_B^L}{Q_B^W - Q_B^D}$$

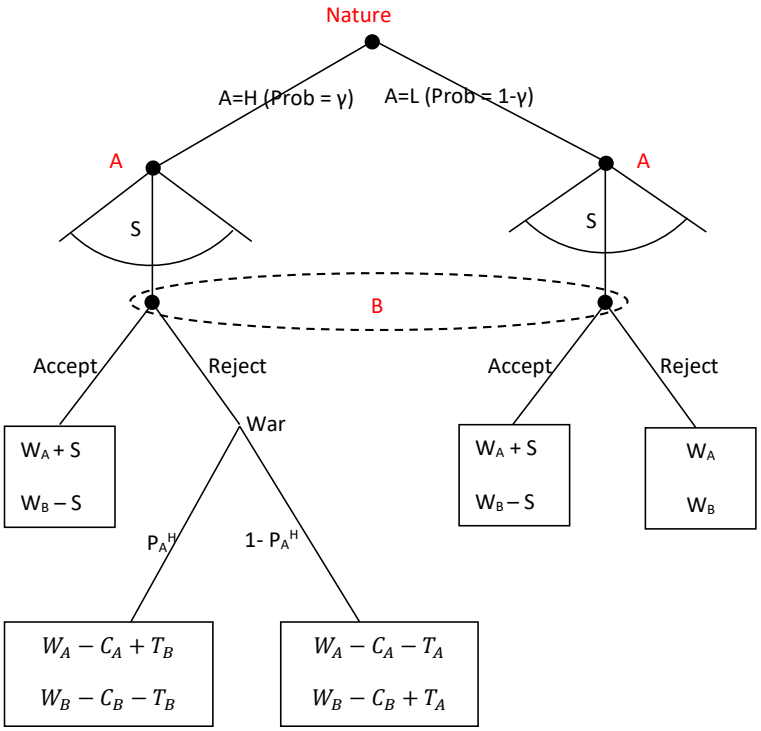
Lemma 2.1. *The analysis of model, where the initiator has private information and will always choose to go to war after being rejected, shows that*

- *A low-type initiator will never propose more than the target expects to accept and so start a war.*
- *When P_A^H is relatively small, $X < 0$, democratic leader is getting less rent from starting a war, so autocracy is more aggressive than democracy.*
- *When P_A^H exceeds the critical value, $X > 0$, democratic leader can benefit from war, democracy become more aggressive.*
- *When P_A^H is relatively small, $Y > 0$, democracy is more likely to be involved in militarized conflicts as a target.*

b. When country A's action is type dependent ($P_A^L < \frac{C_A+T_A}{T_A+T_B} < P_A^H$)

In this case, with probability γ country A is high type, hence will choose to go to war after being rejected; with probability $1-\gamma$ country A is low type, hence will choose to quit the bargaining after being rejected as shown in Figure 2.7.

Figure. 2.7 *Simplified Form When Country A's Action is Type Dependent*



i. Actions of Country B

Then the payoff of playing strategy *Accept* for country B would be

$$E_B(Accept) = W_B - S$$

and the expected payoff of playing strategy *Reject* is

$$E_B(Reject) = \gamma E_B^H(War) + (1-\gamma)E_B(Quit)$$

$$= \gamma[W_B + T_A - C_B - P_A^H(T_A + T_B)] + (1-\gamma)(W_B)$$

When $E_B(Accept) \geq E_B(Reject)$, country B will choose *Accept*. Hence, the maximum amount country B will accept is

$$S^* = \gamma[C_B - T_A + P_A^H(T_A + T_B)]$$

ii. Actions of Country A

Similar to the previous case, country A will only propose either: S^* or $> S^*$. For country A, any proposal smaller than S^* will definitely be accepted by country B and thus is worse than S^*; and any proposal which is bigger than S^* will cause war for sure. If country A is High type, again, as long as its expected payoff from war is bigger or at least equal to the payoff from proposing S^*:

$$E_A^H(> S^*) \geq E_A(S^*)$$

it will prefer B to reject its proposal and then goes to war. Hence we have:

$$P_A^H(W_A - C_A + T_B) + (1 - P_A^H)(W_A - C_A - T_A) \geq W_A + S^*$$

Rearrange it

$$\gamma \leq \frac{P_A^H(T_A + T_B) - T_A - C_A}{P_A^H(T_A + T_B) - T_A + C_B}$$

Therefore, if above inequality is satisfied, country A will propose an amount which is bigger than S^* to let war happen. Otherwise, it will propose exactly S^* and country B will accept it.

If country A is Low type, we have $E_A^L(> S^*) < E_A^L(S^*)$, hence its best strategy is to

propose S^*. Again, country B is willing accept it, no war will occur.

iii. Combine with political regime

If we apply above analysis to the model with political regime, we can get the conditions for initiation of war (See Appendix B.6):

Democracy vs. Democracy:

$$\gamma \leq \frac{P_A^H(T_A+T_B)-T_A-C_A+X+\frac{\alpha_B}{1-\alpha_B}(Q_B^Q-Q_B^l)R}{P_A^H(T_A+T_B)-T_A+C_B-Y} \qquad (=DD)$$

Autocracy vs. Autocracy:

$$\gamma \leq \frac{P_A^H(T_A+T_B)-T_A-C_A}{P_A^H(T_A+T_B)-T_A+C_B} \qquad (=AA)$$

Democracy vs. Autocracy:

$$\gamma \leq \frac{P_A^H(T_A+T_B)-T_A-C_A+X}{P_A^H(T_A+T_B)-T_A+C_B} \qquad (=DA)$$

Autocracy vs. Democracy:

$$\gamma \leq \frac{P_A^H(T_A+T_B)-T_A-C_A+\frac{\alpha_B}{1-\alpha_B}(Q_B^Q-Q_B^l)R}{P_A^H(T_A+T_B)-T_A+C_B-Y} \qquad (=AD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

Again, X and Y are defined the same as before. We compare the right hand sides of the above four conditions and get exactly the same relationships of the magnitude:

If $X < 0$, the leader of a democratic initiator gets less from starting a war than making an acceptable proposal, then

$$DA < AA \quad DD < AD \qquad ①$$

If $X \geq 0$, the leader of a democratic initiator gets more or at least equal from starting a war than making an acceptable proposal, then

$$AA \leq DA \quad AD \leq DD \qquad ②$$

If $Y > 0$, the leader of a democratic targeted country gets more from getting involved in a war than accepting the proposal, then

$$DA \leq DD \quad AA \leq AD \qquad ③$$

Therefore we can draw the same conclusions as before.

Lemma 2.2. *The analysis of model, where the initiator has private information and its action is type dependent, shows that*

- *A low-type initiator will never propose more than the target expects to accept and so start a war.*
- *When P_A^H is relatively small, $X < 0$, democratic leader is getting less rent from starting a war, so autocracy is more aggressive than democracy.*
- *When P_A^H exceeds the critical value, $X > 0$, democratic leader can benefit from war, democracy become more aggressive.*
- *When P_A^H is relatively small, $Y > 0$, democracy is more likely to be involved in militarized conflicts as a target.*

c. When country A will always quit ($P_A^L < P_A^H < \frac{C_A+T_A}{T_A+T_B}$)

In this case, country A will definitely quit after being rejected. Hence, for country B, strategy 'Reject' dominates 'Accept'. So country B will reject any proposals that country A proposes. Since country A will quit the bargaining, no war will happen.

2.4.2 Only Country B Has Types

In the second model, the targeted country in the bargaining (country B) has two types: high capability (with probability γ) or low capability (with probability 1-γ). Country B knows its own type but country A doesn't. Corresponding with whether country B is high

type or low type, the probabilities that country A wins the war are P_A^H or P_A^L respectively, $P_A^H < P_A^L$ (stronger enemy lowers country A's winning probability).

Figure. 2.8 *Game Tree when Country B has Private Information*

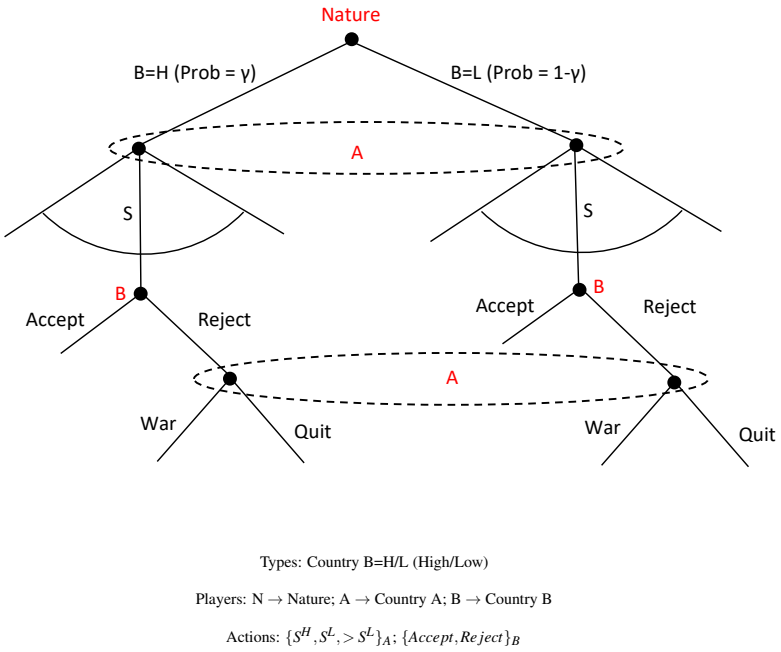


Figure 2.8 shows the extensive form of the game: first, nature decided the type of country B; then country A proposes a proposal S without knowing country B's type. Country B can play either *Accept* or *Reject*. If country B rejects the proposal, country A then decides whether to quit the bargaining or start a war, again, without knowing country B's type.

Definition 2.2. *Strategies for Country B:*

- *(C^H, C^L): both high-type and low-type country B will accept the proposal;*
- *(C^H, R^L): high-type country B accepts and low-type country B rejects the proposal;*

- *(R^H, C^L): high-type country B rejects the proposal and low-type country B accepts;*
- *(R^H, R^L): both high-type and low-type country B will reject the proposal.*

In order to identify equilibria, we need to compare P_A^H and P_A^L with the critical value $\frac{C_A+T_A}{T_A+T_B}$ (the value that decides whether country A would choose to go to war after being rejected), hence there are three cases we need to discuss:

Definition 2.3. *We define the conditions for country A to go to war based as follows:*

- $\frac{C_A+T_A}{T_A+T_B} < P_A^H < P_A^L$*: country A will choose to go to war after being rejected no matter what type of country B it believes;*
- $P_A^H < \frac{C_A+T_A}{T_A+T_B} < P_A^L$*: country A will choose to go to war after being rejected if it believe country B is low type, and quit the bargaining after being rejected if it believe country B is high type;*
- $P_A^H < P_A^L < \frac{C_A+T_A}{T_A+T_B}$*: country A will choose to quit the bargaining after being rejected no matter what type of country B it believes.*

a. When country A will always choose war ($\frac{C_A+T_A}{T_A+T_B} < P_A^H < P_A^L$)

In this case, country A will always choose to go to war after being rejected.

i. Actions of Country B

Now we consider the payoffs for country B by playing each strategy:

(1) If country B plays (C^H, C^L), then the payoff of country B will be

$$E_B^H(C^H, C^L) = E_B^L(C^H, C^L) = W_B - S$$

(2) If country B plays (C^H, R^L), the payoff of high-type country B will be

$$E_B^H(C^H, R^L) = W_B - S$$

The payoff of low-type country B will be the expected payoff from war

$$E_B^L(C^H, R^L) = E_B^L(War)$$

(3) If country B plays (R^H, C^L), the payoff of high-type country B will be

$$E_B^H(R^H, C^L) = E_B^H(War)$$

The payoff of low-type country B will be

$$E_B^L(R^H, C^L) = W_B - S$$

(4) If country B plays (R^H, R^L), the expected payoff of country B will be

$$E_B^H(R^H, R^L) = E_B^H(War)$$

$$E_B^L(R^H, R^L) = E_B^L(War)$$

where

$$E_B^H(War) = W_B + T_A - C_B - P_A^H(T_A + T_B)$$

$$E_B^L(War) = W_B + T_A - C_B - P_A^L(T_A + T_B)$$

Since $P_A^H < P_A^L$, we know $E_B^H(War) > E_B^L(War)$, so we have

$$E_B^H(R^H, C^L) = E_B^H(R^H, R^L) > E_B^L(R^H, R^L) = E_B^L(C^H, R^L)$$

and

$$E_B^H(C^H, C^L) = E_B^L(C^H, C^L) = E_B^H(C^H, R^L) = E_B^L(R^H, C^L) = W_B - S$$

ii. Actions of Country A

We then consider country A's actions.

(1) Suppose $W_B - S \geq E_B^H(R^H, C^L) = E_B^H(R^H, R^L) > E_B^L(R^H, R^L) = E_B^L(C^H, R^L)$, i.e.

$$S \leq C_B - T_A + P_A^H(T_A + T_B)$$

That means both high-type and low-type country B have higher payoff from accepting the proposal than rejecting it regardless the action of other type, thus both types of country B

are willing to accept the proposal. The maximum both types of country B will accept is

$$S^H = C_B - T_A + P_A^H(T_A + T_B)$$

(2) Suppose $E_B^H(R^H, C^L) = E_B^H(R^H, R^L) > W_B - S \geq E_B^L(R^H, R^L) = E_B^L(C^H, R^L)$, i.e.

$$C_B - T_A + P_A^H(T_A + T_B) < S \leq C_B - T_A + P_A^L(T_A + T_B)$$

That means if low-type country B accept the proposal it gets $W_B - S$, which is more than what it can get from playing Reject ($E_B^L(R^H, R^L)$ or $E_B^L(C^H, R^L)$). Hence, when country A proposes less than the right hand side, low-type country B will accept the proposal. Given this, high-type country B will choose to reject the proposal because $E_B^H(R^H, C^L) = E_B^H(R^H, R^L) > W_B - S$. The maximum low-type country B will accept is

$$S^L = C_B - T_A + P_A^L(T_A + T_B)$$

(3) Suppose $E_B^H(R^H, C^L) = E_B^H(R^H, R^L) > E_B^L(R^H, R^L) = E_B^L(C^H, R^L) > W_B - S$, i.e.

$$S > C_B - T_A + P_A^L(T_A + T_B) = S^L$$

That means both high-type and low-type country B have higher payoff from rejecting the proposal than accepting it regardless the action of other type, thus both types of country B will reject the proposal.

Definition 2.4. *Country A's belief is as follow:*

- *If it proposes $S \leq S^H$: both types of country B will accept the proposal;*
- *If it proposes $S^H < S \leq S^L$: low-type country B will accept the proposal, and high-type country B will reject;*
- *If it proposes $S > S^L$: both types of country B will reject the proposal.*

Country A will only propose either: S^H, S^L or any amount which is bigger than S^L (denoted as $> S^L$). It is clear that $S^H < S^L$ because $P_A^H < P_A^L$. For country A, any proposal smaller than S^H will definitely be accepted by both types of country B and thus is worse than S^H; similarly any proposal between S^H and S^L is worse than S^L ; and any proposal which is bigger than S^L will cause war for sure. Therefore, country A has three strategies: S=$\{S^H$, S^L, $> S^L\}$.

Therefore, country A compares its expected payoff from proposing three different strategies described above. The expected payoffs of country A will be

$$E_A(S^H) = W_A + S^H$$

$$E_A(S^L) = \gamma E_A^H(War) + (1-\gamma)(W_A + S^L)$$

$$E_A(> S^L) = \gamma E_A^H(War) + (1-\gamma)E_A^L(War)$$

where

$$E_A^H(War) = W_A - T_A - C_A + P_A^H(T_A + T_B)$$

$$E_A^L(War) = W_A - T_A - C_A + P_A^L(T_A + T_B)$$

We can prove $E_A(> S^L)$ is always worse than $E_A(S^L)$. War only happens when $E_A(S^L) \geq E_A(S^H)$ so country A prefer the bigger proposal S^L. When country B is a high type (with probability γ), it will reject the proposal and war will happen. We solve $E_A(S^L) \geq E_A(S^H)$, and get the condition for initiation of war

$$\gamma \leq \frac{(P_A^L - P_A^H)(T_A + T_B)}{C_A + C_B + (P_A^L - P_A^H)(T_A + T_B)}$$

The inequality above suggests that when country B's probability of being high type is lower than the right hand side, country A tends to propose a higher value S^L and if country B is indeed high type the war will happen (the probability of war occurrence depends on γ). Hence the inequality reveals country A's incentive of being aggressive.

Notice the right hand side of above inequality decreases with the increase of $C_A + C_B$. That means the higher the war costs of two countries are, the more likely that S^H becomes the best strategy for country A and thus war would be less likely to happen.

iii. Combine with political regime

If we apply above analysis to the model with political regime, we can get the conditions of

proposing strategy S^L for country A under different regime types (See Appendix B.7). In other words, they are the conditions under which war could happen with probability γ:

Democracy vs. Democracy:

$$\gamma \leq \frac{(P_A^L - P_A^H)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]}{C_A + C_B + (P_A^L - P_A^H)(T_A + T_B) - X - Y} \qquad (= DD)$$

Autocracy vs. Autocracy:

$$\gamma \leq \frac{(P_A^L - P_A^H)(T_A + T_B)}{C_A + C_B + (P_A^L - P_A^H)(T_A + T_B)} \qquad (= AA)$$

Democracy vs. Autocracy:

$$\gamma \leq \frac{(P_A^L - P_A^H)(T_A + T_B)}{C_A + C_B + (P_A^L - P_A^H)(T_A + T_B) - X} \qquad (= DA)$$

Autocracy vs. Democracy:

$$\gamma \leq \frac{(P_A^L - P_A^H)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]}{C_A + C_B + (P_A^L - P_A^H)(T_A + T_B) - Y} \qquad (= AD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1 - P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1 - P_A^L)Q_B^W + P_A^L Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

Again, X is the first term of the right hand side of (2.1),the weighted rents margin of the leader in country A (initiator). Yet, Y is slightly different with the case when only country A has types. Y is the second term of right hand side of (2.1), the weighted rents margin of the leader in country B (target).

Similarly, we assume the right hand side of above four conditions to be 'DD', 'AA', 'DA' and 'AD' respectively. We can get the relationships of the magnitude as follows:
If $X < 0$, the leader of a democratic initiator gets less from starting a war than making an acceptable proposal, then

$$DA < AA \quad and \quad DD < AD \qquad ①$$

If $X \geq 0$, the leader of a democratic initiator gets more or at least equal from starting a war than making an acceptable proposal, then

$$AA \leq DA \quad and \quad AD \leq DD \qquad ②$$

If $Y > 0$, the leader of a democratic targeted country gets more from getting involved in a war than accepting the proposal, then

$$DA < DD \quad and \quad AA < AD \qquad ③$$

If $X < 0$, according to ① that, no matter whether the targeted country is a democracy or an autocracy, the autocratic attacker is always more likely to start a war; vice versa. If $Y > 0$,

according to ③ that, no matter whether the attacker is a democracy or an autocracy, the autocracy is always more likely to be the target. Notice that

$$X < 0 \quad \text{when} \quad P_A^H < \frac{Q_A^L - Q_A^D}{Q_A^W - Q_A^D}$$
$$Y > 0 \quad \text{when} \quad P_A^L < \frac{Q_B^W - Q_B^L}{Q_B^W - Q_B^D}$$

Lemma 2.3. *The analysis of model, where the target country has private information and the initiator will always choose to go to war after being rejected, shows that*

- *When P_A^H is relatively small, $X < 0$, democratic leader is getting less rent from starting a war, so autocracy is more aggressive than democracy.*
- *When P_A^H exceeds the critical value, $X > 0$, democratic leader can benefit from war, democracy become more aggressive.*
- *When P_A^L is relatively small, $Y > 0$, democracy is more likely to be involved in militarized conflicts as a target.*

We find the conclusions are basically consistent with the case when only country A has types. Yet, P_A^H has different meanings in these two cases. The P_A^H in previous conclusions are the winning probabilities when country A is high type, while in here it refers to the types of country B.

b. When country A's action is type dependent ($P_A^H < \frac{C_A+T_A}{T_A+T_B} < P_A^L$)

In this case, the belief of country A is that if country B is low type then country A should

go to war; if country B is high type then country A should quit the bargaining.

i. Actions of Country B

Now we consider the possible strategies for country B:

(1) If country B plays (C^H, C^L), the payoff of country B will be

$$E_B^H(C^H,C^L) = E_B^L(C^H,C^L) = W_B - S$$

(2) If country B plays (C^H, R^L), country A knows country B is low type if it gets rejected and so will choose to go to war. Then the payoff of high-type country B will be

$$E_B^H(C^H,R^L) = W_B - S$$

The payoff of low-type country B will be the expected payoff from war

$$E_B^L(C^H,R^L) = E_B^L(War)$$

(3) If country B plays (R^H, C^L), country A knows country B is high type if it gets rejected and so will quit the bargaining. Then the payoff of high-type country B will be

$$E_B^H(R^H,C^L) = W_B$$

The payoff of low-type country B will be

$$E_B^L(R^H, C^L) = W_B - S$$

(4) If country B plays (R^H, R^L), country A cannot distinguish the type of country B. Applying Bayesian rule, country A's conditional probability of country B being high type and low type would be

$$Pr\{High|Reject\} = \frac{Pr\{Reject|High\}Pr\{High\}}{Pr\{Reject|High\}Pr\{High\} + Pr\{Reject|Low\}Pr\{Low\}}$$
$$= \frac{1*\gamma}{1*\gamma + 1*(1-\gamma)} = \gamma$$

$$Pr\{Low|Reject\} = 1 - Pr\{High|Reject\} = 1 - \gamma$$

With probability γ country A believes country B is high type and will quit the bargaining; with probability $1-\gamma$ country A believes country B is low type and will choose to go to war. Then the expected payoff of country B will be

$$E_B^H(R^H, R^L) = \gamma W_B + (1-\gamma)E_B^H(War)$$

$$E_B^L(R^H, R^L) = \gamma W_B + (1-\gamma)E_B^L(War)$$

where

$$E_B^H(War) = W_B + T_A - C_B - P_A^H(T_A + T_B)$$

$$E_B^L(War) = W_B + T_A - C_B - P_A^L(T_A + T_B)$$

Since $P_A^H < P_A^L$, we know $E_B^H(War) > E_B^L(War)$, so we have

$$E_B^H(R^H, C^L) > E_B^H(R^H, R^L) > E_B^L(R^H, R^L) > E_B^L(C^H, R^L)$$

and

$$E_B^H(C^H, C^L) = E_B^L(C^H, C^L) = E_B^H(C^H, R^L) = E_B^L(R^H, C^L) = W_B - S$$

ii. Actions of Country A

We then consider country A's actions.

(1) Suppose $W_B - S \geq E_B^L(R^H, R^L)$, i.e.

$$S \leq (1-\gamma)[C_B - T_A + P_A^L(T_A + T_B)]$$

That means if low-type country B accept the proposal it gets $W_B - S$, which is higher than what it can get from playing Reject ($E_B^L(R^H, R^L)$ or $E_B^L(C^H, R^L)$). Hence, when country A propose less than the right hand side, low-type country B will accept the proposal. Given this hight-type country B will choose to reject the proposal because $E_B^H(R^H, C^L) > E_B^H(C^H, C^L)$. The maximum both types of country B will accept is

$$S^* = (1-\gamma)[C_B - T_A + P_A^L(T_A + T_B)]$$

(2) Suppose $W_B - S < E_B^L(R^H, R^L)$, i.e.

$$S > (1-\gamma)[C_B - T_A + P_A^L(T_A + T_B)] = S^*$$

That means if high-type country B accept the proposal it gets $W_B - S$, which is less than what it can get from playing Reject ($E_B^H(R^H, C^L)$ or $E_B^H(R^H, R^L)$). Hence, when country A proposes more than the right hand side, high-type country B will reject the proposal. Given this, low-type country B will choose to reject the proposal because $E_B^L(R^H, R^L) > E_B^L(R^H, C^L)$.

Definition 2.5. *Country A's belief is as follow:*

- *If it proposes $S \leq S^*$: low-type country B will accept the proposal, and high-type country B will reject;*
- *If it proposes $S > S^*$: both types of country B will reject the proposal.*

Similar to the previous cases, country A will only propose: S^* and any amount which is bigger than S^* (will be called as $> S^*$).

Therefore, country A compares its expected payoff from proposing two different strategies described above. If it proposes the first strategy, With probability γ country B is high type and will reject the proposal so country A will quit the bargaining; with probability $1-\gamma$

country B is low type and will accept the proposal. The expected payoff of country A is

$$E_A(S^*) = \gamma W_A + (1-\gamma)(W_A + S^*)$$

If country A proposes the second strategy, both types of country B will reject the proposal. Given country A is rejected its conditional beliefs are updated as mentioned in discussion about country B's strategy (R^H, R^L): with probability γ country A believes country B is high type and will quit the bargaining; with probability $1-\gamma$ country A believes country B is low type and will choose to go to war. The expected payoff of country A will then be

$$E_A(> S^*) = \gamma W_A + (1-\gamma)E_A^L(War)$$

where

$$E_A^L(War) = P_A^L(W_A - C_A + T_B) + (1 - P_A^L)(W_A - C_A - T_A)$$

War only happens if country A proposes more than S^*. Country A would like to propose more than S^* if

$$E_A(> S^*) \geq E_A(S^*)$$

We solve and get

$$1-\gamma \leq \frac{P_A^L(T_A+T_B) - T_A - C_A}{P_A^L(T_A+T_B) - T_A + C_B}$$

The inequality above suggests that when country B's probability of being high type is higher than the right hand side, country A prefers to propose more than S^* and choose to go to war with probability $1-\gamma$. Hence the inequality reveals country A's incentive of

being aggressive.

iii. Combine with political regime

If we apply above analysis to the model with political regime, we can get the conditions of proposing strategy $> S^*$ for country A under different regime types (See Appendix B.8). In other words, they are the conditions under which war could happen with probability $1-\gamma$:

Democracy vs. Democracy:

$$1-\gamma \leq \frac{P_A^L(T_A+T_B)-T_A-C_A+X}{P_A^L(T_A+T_B)-T_A+C_B-Y} \qquad (=DD)$$

Autocracy vs. Autocracy:

$$1-\gamma \leq \frac{P_A^L(T_A+T_B)-T_A-C_A}{P_A^L(T_A+T_B)-T_A+C_B} \qquad (=AA)$$

Democracy vs. Autocracy:

$$1-\gamma \leq \frac{P_A^L(T_A+T_B)-T_A-C_A+X}{P_A^L(T_A+T_B)-T_A+C_B} \qquad (=DA)$$

Autocracy vs. Democracy:

$$1-\gamma \leq \frac{P_A^L(T_A+T_B)-T_A-C_A}{P_A^L(T_A+T_B)-T_A+C_B-Y} \qquad (=AD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^L Q_A^W + (1-P_A^L)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^Q R\}$$

We have X and Y as the weighted rents margin of the leader in both countries. However the winning probability has changed again. In X and Y, P_A^L represents the winning probability of country A when country B is low type.

We get the relationships of the magnitude as follow:

If $X < 0$, the leader of a democratic initiator gets less from starting a war than making an acceptable proposal, then

$$DA < AA \quad and \quad DD < AD \qquad ①$$

If $X \geq 0$, the leader of a democratic initiator gets more or at least equal from starting a war than making an acceptable proposal, then

$$AA \leq DA \quad and \quad AD \leq DD \qquad ②$$

If $Y > 0$, the leader of a democratic targeted country gets more from getting involved in a war than accepting the proposal, then

$$DA < DD \quad and \quad AA < AD \qquad ③$$

Notice that

$$X < 0 \quad \text{when} \quad P_A^L < \frac{Q_A^L - Q_A^D}{Q_A^W - Q_A^D}$$
$$Y > 0 \quad \text{when} \quad P_A^L < \frac{Q_B^W - Q_B^Q}{Q_B^W - Q_B^D}$$

Therefore we can draw the similar conclusions as before.

Lemma 2.4. *The analysis of model, where the target country has private information and the initiator's action is type dependent, shows that*

- *When P_A^L is relatively small, $X < 0$, democratic leader is getting less rent from starting a war, so autocracy is more aggressive than democracy.*
- *When P_A^L exceeds the critical value, $X > 0$, democratic leader can benefit from war, democracy become more aggressive.*
- *When P_A^L is relatively small, $Y > 0$, democracy is more likely to be involved in militarized conflicts as a target.*

The winning probability that used to distinguish the aggressive level of democracy and autocracy become P_A^L rather than P_A^H.

c. When country A will always quit ($P_A^H < P_A^L < \frac{C_A+T_A}{T_A+T_B}$)

In this case, no matter what type country B is, country A will quit after being rejected. So country B will reject both proposals - S^H and S^L. No war will happen.

2.4.3 Summary

The analysis of models with asymmetric information provides consistent results.

Proposition 2.5. *To summarize the two models, we conclude*

- *A low-type initiator will never propose more than the target expects to accept and so start a war.*
- *If the initiator is high type, when P_A (its winning probability in war) is relatively small, $X < 0$ and $Y > 0$, an autocratic initiator is more aggressive than a democratic initiator, and a democracy is more likely to be involved in conflict escalation as a target; otherwise, when P_A exceeds the critical value, $X > 0$, a democratic initiator will be more aggressive.*
- *When the type of target is not certain, country A (initiator) considers its probability of victory when facing the strongest-type target possible. As this probability exceeds the critical value, $X > 0$, a democratic initiator, once again, will be more aggressive.*
- *A low-type democratic target can be more likely to escalate conflict than an autocratic target as long as its rival has a relatively low winning probability (P_A), so $Y > 0$. In other words, when its own winning probability (P_B) is sufficiently high.*

$$X = \frac{\alpha_A}{1-\alpha_A}\{[P_A Q_A^W + (1-P_A)Q_A^D] - Q_A^L\}R$$

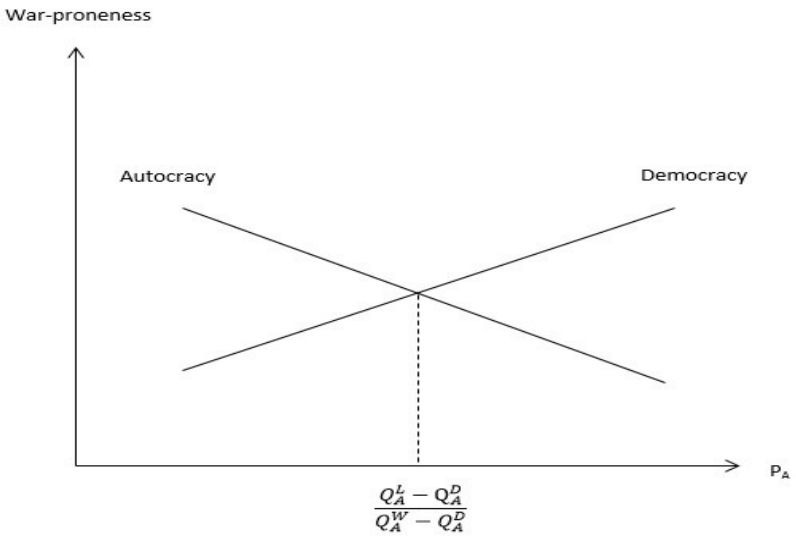
$$Y = \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A)Q_B^W + P_A Q_B^D] - Q_B^L\}R$$

X is the weighted rents margin between making an acceptable proposal and starting a war for the ruler of a democratic attacker (country A) to consider. For the leader in a democratic target (country B), Y is the weighted rents margin between getting involved in a war and accepting the proposal.

Corollary 2.1. *There is a critical value for P_A to characterise the war-proneness level of different regime types in the conflict.*

This can be represented by the following graph.

Figure. 2.9 *War-proneness Level with Probability of Victory*



With the incentive of staying in office, a democratic leader who has high expectation of the probability of victory in war is very likely to use war as a way to reveal his power in the forthcoming re-election. This political incentive drives a democracy to be more aggressive than an equivalent autocracy whether or not it is an initiator or a target in conflict.

2.5 Conclusion

The empirical findings on the relation between political regimes and war are ambiguous. Supporters of the concept of "democratic peace" indicate that democracies rarely fight with each other, while the others argue that democracy is not less war-prone than any other regime type. This chapter helps to theoretically understand the relationship between democracy and peace.

The basic two-country conflict model is extended by introducing political regime type and asymmetric information. The ruler in each country maximizes a linear combination of the rent and the public's welfare. The ruler in the democracy considers the probability of losing the office in a post-war re-election, while the autocrat has no such risk. This structural feature affects the rulers' incentives for making decisions about war. We conclude that with perfect information autocratic leaders cannot make extra profit from going to war. The varied survival rate of re-election in a democracy makes the escalation of conflict more likely.

The second extension incorporates the issue of information asymmetry. The private information of each side is categorized by military proficiency. We have two main findings: firstly, a low-type initiator will never start a war intentionally; secondly, a democracy becomes more aggressive when its probability of victory in war is high, as the ruler expects a positive rent margin from war (that is, the expected rent from starting a war outweighs the rent from reaching a peaceful settlement). An ideal way to test this conclusion is to look at whether democracies do have more frequent conflict escalation when its winning probability is high. The problem is that there may not be enough data on conflict escalation for democracies.

Our results also imply that a democracy will be less aggressive if the expected probability of victory is relatively small. Hence, "democratic peace" can be explained by a low expected probability of victory between democracies. This may be due to the fact that most democracies have been economically developed states since the end of World War II. An opponent's strong economic and military capabilities inevitably lower the winning probability of one's own side. Nevertheless, the question of whether democracies actually do have a low expected probability of victory in war against each other still requires further study.

Chapter 3

Coalition Formation: A Model of Civil War

Abstract

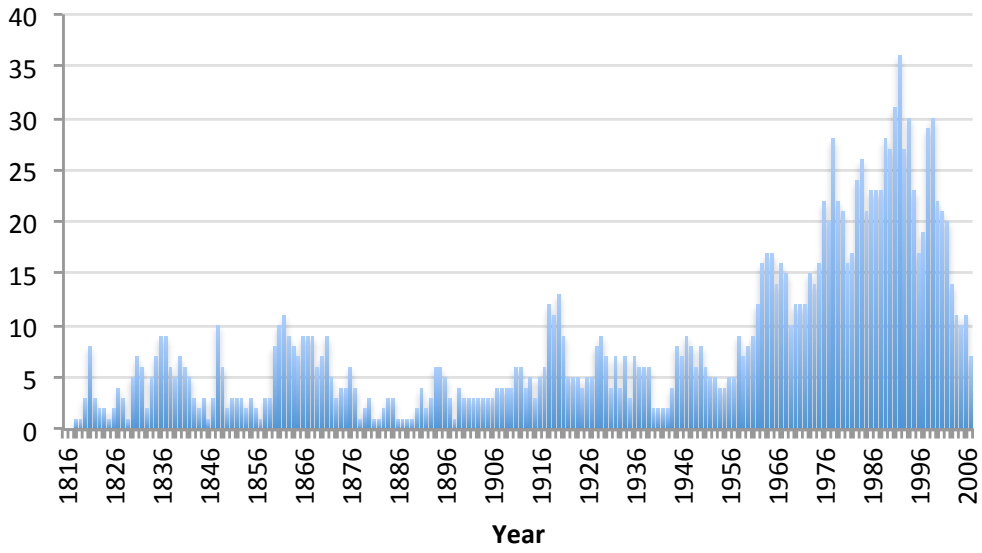
This chapter focuses on intra-state conflict between a central government and potential rebel groups, and provides a detailed understanding on the occurrence of rebellion. First, the question of how more than two armed groups can compete within a country is studied. In a model with endogenous military input, taxation is found to have an impact on the incentive for the rebels to form a coalition. Second, we show how the commitment problem can lead to the outbreak of civil war. In both the short term and the long term, a peaceful settlement can be achieved and maintained if the costs of war are high.

Key Words: Civil War, Coalition, Commitment Problem

3.1 Introduction

The past few decades have witnessed an explosion of internal armed conflict all around the world. Figure 3.1 shows the total number of ongoing civil wars in the world from 1816 to 2007. Many nations have experienced a civil war since 1960, especially around 1990. As the most prevalent form of large-scale violence, civil wars are difficult to stop once started and cause destructive consequences to life, economy and society. Yet while being central to nations' development, civil war has been under-researched, with the economics literature particularly sparse. Existing theory has provided some insight but is incomplete, without a detailed analysis of key areas, like why armed groups form and cohere, or how more than two armed sides compete as well as how the commitment problem may prevent settlements from being reached. This chapter aims to answer these questions.

Figure. 3.1 *Number of Ongoing Civil Wars 1816-2007*



Source: Intra-state War Database (v4.1), The Correlates of War (COW) Project

Civil war occurs as a result of rebellion by rebel groups within a country. When considering the causes of rebellion, the possible explanations include both the motivation and feasibility of this phenomenon. In previous researches that have been dedicated to the causes and consequences of rebellion, there has been a greater focus on motivation than on feasibility. For example, traditional political analyses either assumed or asserted some particular 'root cause' of civil war, usually traced to a historical grievance. They argue some societies are structured so that particular groups suffer exceptional exploitation, and this in turn provokes rebellion. By contrast, some other literature have assumed that the motivation for rebellion is not grievance but greed - the extortion of economic rents on a grand scale by quasi-criminal rebel groups. This is because, potentially, rebels may also be motivated by the opportunities that organized violence generates for private gain.

However, a satisfactory theory should be able to explain both motivation and feasibility as both of them are necessary to constitute a complete explanation of civil war. More importantly, the two decisive explanatory factors for rebellion, described as 'opportunity' and 'viability', should be studied. The occurrence of civil war largely depends on the weighing of the opportunities and viability of rebellion militarily and financially, that is, war occurs if the incentive for rebellion is sufficiently large relative to the costs. Literature that follows this idea suggests war as a means to resolve conflict is inefficient and that the credible-commitment problem is a key consideration when studying the reasons for war. In addition, the allied and adversarial relationships have also been studied by other theorists in terms of the coalition forming.

Yet most studies discuss coalition and the commitment problem within the context of international war, and rarely mention how the situation will be different with domestic conflict. The current endogenous coalitions theory only considers individual-level secession, excluding joint behaviours by groups of agents. Hence, an analysis of group coalition and credible-commitment problem is needed to complete the study of civil war. Recent researches tend to suggest that war is not an alternative to negotiation but an extension of it. The theory is that war should be viewed as part of a dynamic bargaining process, during which a limited war happens in equilibrium and a negotiated settlement appears after a period of war (Leventoğlu and Slantchev, 2007; Sánchez-Pagés, 2009; Yared, 2010).

Despite many differences, intra- and inter-state conflicts share plenty of common features. They both consist of two or more hostile sides and are normally accompanied by military activities. Unlike the model for inter-state conflict, which focuses on the bargaining between countries, intra-state conflict is over particular domestic issues such as taxation (or any other kind of exploitation) and redistribution (represented by domestic policy). Our model for intra-state conflict is designed to study how disagreement over these domestic issues are able to explain the occurrence of rebellion.

Our study, based on a game-theoretic framework, attempts to analyse the factors that cause civil war by considering the problems that prevent reaching a settlement in the bargaining between government and rebel groups and discussing the issue of maintaining post-settlement peace. Section 3.2 reviews related literature. Section 3.3 proposes a basic bargaining model which shows that with complete information, the subgame perfect Nash

equilibrium involves no civil war. Section 3.4 analysis the coalition problem by taking a two-group case as an example. By considering endogenous defence spending, we also show that whether fighting within coalition is allowed will affect groups' decision on forming coalition in the first place. Finally, in section 3.5, we extend the model by considering the commitment problem, i.e. that the rebel group can still choose to rebel after receiving transfers from the government. Two possible equilibria are identified. Since both civil war and peaceful settlement can happen in equilibria, we discuss a repeated game model and analyse under what conditions civil war is prevented and the eventual settlement becomes self-enforcing. Section 3.6 presents the conclusion.

3.2 Literature Review

The most common definition of civil war requires sustained combat, organised military action and at least 1,000 battle-related deaths in one year (Blattman and Miguel, 2010). Hence, to study the causes of civil war, the emergence and persistence of a rebel army must be explained. Collier and Hoeffler (1998) investigate the generic causes of civil wars, built on the idea that rebellion occurs if the incentives for rebellion outweigh the costs. They find that higher per capita income reduces that risk of civil war, possibly because higher income increases the opportunity cost of rebellion. More importantly, they discover a non-monotonic relationship between civil wars and ethnic diversity, that is, highly fractionalised societies are no more prone to war than highly homogeneous ones. This may be due to the high coordination costs between fractionalised rebels.

Grossman (1991) studies insurrection by treating it and its deterrence or suppression as economic activities where peasant families allocate their labour time among insurrection, soldering and production. In equilibrium no time is actually devoted to insurrection and the results depend on the technology of insurrection. The effect of high tax rate is discussed. Grossman suggests high tax rate not only depresses the tax base due to the decreasing of the fraction of time that peasants devote to production but also increases the probability of a successful insurrection.

As one of the possible manifestations of intra-state conflict, revolutions are usually unanticipated. Kuran (1989, 1995) discusses why revolutionary surprises occur with the aid of a collective choice model that distinguishes between individuals' privately held political preferences and those they espouse in public. He provides an explanation that revolutionary surprise is due to preference falsification - people who come to dislike their government are apt to hide their desire for change under perceived social pressures. Hence, a government that appears unshakeable might see its support crumble at the most minor shock.

Collier and Hoeffler (1998) investigate the economic causes of civil wars. They use probit and tobit regressions on data for the occurrence and duration of civil wars 1960-92 and find four variables that significantly determine both the duration and the probability of civil wars. More particularly, they suggest that the higher is per capita income on an internationally comparable measure, the lower is the risk of civil war, which is interpreted as due to the effect of higher income on the opportunity cost of rebellion.

Previous work in political science offers an account of conflict in terms of motive: rebellion occurs when grievances are sufficiently acute that people want to engage in violent protest. However, much recent literature that has focused on the motivation for rebellion proposes a contentious distinction between 'greed and grievance'. Collier and Hoeffler (2000) compare the greed and grievance models of conflict. In the grievance model, rebellion is a protest generated by objective grievances: ethnic or religious hatreds, inequality, oppression, historical vengeance, and even political exclusion, while the greed model postulates the cause of initial conflict as an economic calculus of relative military advantage, finance expenditure, perceived benefits, and the costs of rebellion. They suggest both greed and misperceived grievance provide the same constraints for either not-for-profit or profit-seeking rebel organizations to exist. Thus, an integrated model that allows both greed and grievance to initiate conflict is needed.

Whereas traditional political analyses have either assumed or asserted some particular 'root cause' of civil war, usually traced to a historical grievance or greed, Collier et al. (2009) have transferred their attention from motivation to the feasibility of rebellion. In most circumstances establishing a rebel army would be both prohibitively expensive and extremely dangerous regardless of its agenda. Hence, the relatively rare circumstances in which rebellion is materially feasible are therefore likely to constitute an important part of any explanation of civil war. They argue that it is the factors that are important for the financial and military feasibility of rebellion but are unimportant for motivation decisively increase the risk of civil war, and present a 'feasibility hypothesis': rebellion occurs where

it is militarily and financially feasible. In their empirical analysis, several variables are identified as proxies for each of the three major perspectives: feasibility, and the two main variants of motivation, greed and grievance, and examine how likely they are to determine a country to experience an outbreak of civil war. The result is consistent with the feasibility hypothesis, as the variables that appear to be significant point to the primacy of feasibility over motivation. This implies that, to avoid civil war, one should make it either militarily or financially difficult or both.

However, rather than being orthogonal to the feasibility of civil war, motivation could be determined by it. Weinstein (2005) studies how natural resources are related to the onset of civil war, especially how they affect the character of rebel groups through recruitment. He shows that, due to the self-selection of recruits, a rebel group initially motivated by grievance may transform into a loot-seeking one as long as there is manifest scope for loot-seeking initially. Collier (2000) emphasises the circumstance of loot-seeking rebellion. His justification is that even if the rebellion is initiated purely by grievance at the beginning, predation may be the sole means by which a rebellion can sustain itself financially. Hence the analysis of rebellion as if it were motivated by predation may have a more general application.

Most of the literature that tries to explore the motive-opportunity dichotomy follows the Hirshleifer's (1995b; 2001) classification of the possible causes of civil war: preferences, opportunities and perceptions. Both motivation and feasibility theory share some important similarities, which are described by the common conditions of rebellion - 'opportunity'

and 'viability'. As pointed out by Collier and Sambanis (2002), understanding the causes of observed conflict is not necessarily synonymous with understanding its motivation, as motive may or may not be more decisive than opportunity for action. On one hand, conflict can be explained by well-grounded preferences such as the exceptional circumstances of exploitation supported by the theory of grievance. On the other hand, greed exists in most societies, thus motivation cannot be the only explanation of rebellions. Collier and Sambanis then conclude it is the opportunity that makes rebellion only profitable in some societies. Moreover, both grievance and opportunity for rebellion can be misperceived by potential rebels. Nevertheless, whether rebel groups will resort to large-scale violence depends on their perceptions when weighing between grievance and the opportunities, including the availability of finance, the military weakness of the government and so on.

Theoretical studies then try to provide a sense of how civil war is initiated by converting the conditions of financial and military viability into theoretical models. Generally, an equilibrium is found: war, by all measures, is Pareto inefficient. The question is, why do we still observe war where peaceful agreement is not reached? Azam (1995) sets up a game-theoretic model to discuss the choice of the government between defence expenditure and the redistribution of state money within a peace-keeping policy. He focuses on the potential for a Pareto-improving bargain that bans looting and finds that, without side payments, such a bargain is unlikely. At the same time, this kind of settlement, that is rational during the conflict, becomes irrational however, once the violence stops. The time-inconsistency causes what is called 'commitment problem', which is considered to be one of the most pervasive reasons for bargaining failure.

Genicot and Skaperdas (2002) develop a model in which resources can be devoted to production, fighting and investment in conflict management. They begin with the proposal that arming and war occur due to the absence of commitment, because if commitment is possible, potential adversaries can always reach a settlement that leads to better outcomes than costly war (Fearon, 1995). Hence, they then address the issue of what prevents parties from making commitment. By taking into account the fact that conflict management is indeed costly, their results show that lower initial wealth causes lower investment in conflict management, and thus increases the risk of war. They have also found that the presence of a larger number of adversaries in cases of international conflict tends to increase the likelihood of peace, but has the opposite effect in cases of domestic conflict. Although in Hirshleifer's (1995a) model, a greater number of adversaries intensifies conflict by increasing the resources devoted to guns (fighting) and reducing the resources devoted to butter (production). Genicot and Skaperdas argue that when there are more adversaries the returns from investment in conflict management could be higher.

Another theoretical paper by Anesi (2012) incorporates both policies to appease secessionist aspirations and informational asymmetries, and shows how uncertainty leads to the occurrence of secession. In particular, Anesi models a country with two politically economically interdependent regions, the majority and the minority, represented by a governing policy-maker and a minority leader respectively. The policy-maker proposes a policy compromise to the minority, the minority leader must then decide whether this compromise is acceptable.

All three papers discussed above (Anesi, 2012; Azam, 1995; Genicot and Skaperdas, 2002) assume the number and identity of groups that might resort to conflict are given exogenously. However, even though conflict is profitable according to the "Machiavelli Theorem" proposed by Hirshleifer (1994), the number of rebel groups can be endogenous, which leads to the forming of coalitions. Bloch et al. (2006) and Garfinkel (2004) analyse non-cooperative models based on the endogenous coalitions theory. They show that a grand coalition is efficient in the sense that agents are always better off. Yet they have only considered individual-level secession, and do not consider joint secessions by groups of agents.

Hence, a complete analysis of group secessions is still needed to analyse the stability of the coalition. Esteban and Ray (2003) develop a multi-player contest with incomplete information, and show that, as long as there are at least four agents, no social decision rule can be Pareto-improving and conflict ensues. Another work by Ray (2009) studies the similar question of coalition formation during conflict but in a world with complete information, and with no commitment issue and indivisible issue. Ray analyses societies that are divided to be conflictual, based on different societal markers such as class, geography, religion, or ethnicity. Therefore, due to this divisions of society, conflict over private resources is difficult to prevent. However, in contrast, when the conflict is over public goods, such diversity promotes social stability.

Spending on national defence is a good example of a public good. Bruce (1990) introduces the cost of arms race, i.e. defence expenditure, into the alliance public good

framework of Olson and Zeckhauser (1966). It is shown that an increase in cooperators' defence spending in the alliance may cause their welfare to be lower. However, his analysis is restrictive in a three-country model, that is, when one bloc has two countries and another has a single country. Ihori (2000) extends Bruce's theory by discussing a multi-country model between two blocs. Ihori suggests that when there are a large number of allied countries cooperative behaviour generates better outcomes than non-cooperative behaviour despite the negative effect of greater adversarial defence spending. He also examines the Stackelberg leader-follower game and shows that the leader bloc will be better off by cooperating while the follower bloc is the opposite.

Both Bruce and Ihori have focused equally on the allied and the adversarial relationships in inter-state conflict. Returning to the theories of civil war, one particular feature is that the government has an opportunity to violate the terms of a settlement with little risk of reprisal, whereas the rebels may be unable to commit to demobilize and disarm and prevent the entry of new rebel groups (Collier and Sambanis, 2002; Walter, 1997), which provides either side with an incentive to renege after the settlement is reached. To address the credible-commitment problem, Walter (1997) emphasizes the importance of third-party guarantees which ensure cheating becomes difficult and costly.

In studies by Fearon (1995) and Powell (2004), inefficient conflict results from large, rapid shifts in the distribution of power. Powell (2006) shows that, in each of the commitment problems described by Fearon, the same mechanism involving large shifts in the future distribution of power can also explain the breakdowns of bargaining and war.

Similarly, Garfinkel and Skaperdas (2000) take considerations over the future into account. Unlike Skaperdas and Syropoulos (1996) who make no distinction between fighting and negotiation under the threat of conflict, and thus maintain that the intensity of conflict is indicated solely by the amount of arming, Garfinkel and Skaperdas present a typical guns-or-butter model where fighting and settling are distinct and arming happens in either situation. Because there is a possibility that fighting can weaken or even eliminate the adversary, potential peace reduces the arming costs and secures bigger profits in the future. They find that the more salient is the future, the more likely are fighting and war to occur. Their approach suggests that the likelihood of war is affected by each side's valuation of the future versus the present.

An empirical regularity shows that the risk of war recurrence in postwar societies is higher than the risk of the onset of a new war in countries with no prior war history. The causal links are not clear. Yet, it is indeed observed that hatred, and other rebellion-specific capital accumulated during civil war, make further conflict more likely (Collier and Sambanis, 2002). There is emerging literature that tends to view war as part of a dynamic bargaining process (Sánchez-Pagés, 2009; Yared, 2010), as it has been reported that most conflicts end with a negotiated settlement rather than a complete elimination of one side (Leventoğlu and Slantchev, 2007). Leventoğlu and Slantchev argue that although the credible-commitment problem provides an explanation of the outbreak of war, it does not answer the question of how fighting resolves the commitment problem, unless we view war as part of the process that reflects the outcomes of fighting.

None of the above studies that discuss the commitment problem as one important cause of the outbreak of war have considered the key component in secession behaviours - how coalition between rebel groups forms. Those who consider the group-coalition problem and dynamic bargaining theory do not focus on the content of intra-state conflict where group-forming behaviours are far more common and postwar conflicts are more severe. Therefore, this chapter will analyse these problems within the framework of civil war.

3.3 Basic Model

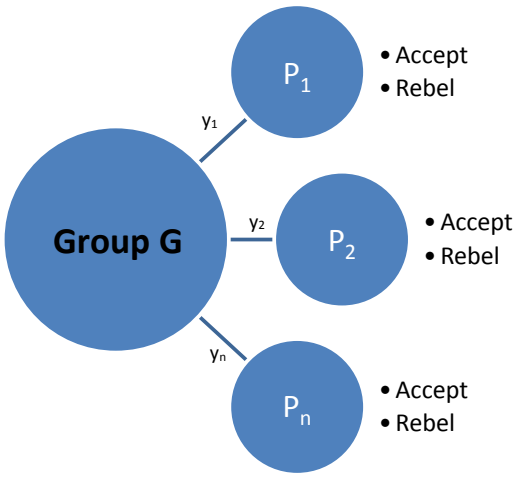
Hirshleifer (1991) provides a foundation for the standard game-theoretic model of civil war. In a simple two-stage setting, the choice between defence expenditure and the redistribution of state money within a peace-keeping policy is discussed. Following the same structure, we present a model of conflict between a central government (denoted by group G) and several potential rebel groups (denoted by group P_i where i = 1, 2, . . . , n). We assume that the initial control over the country is with group G who seeks to protect the property rights and provide other services in return for taxes (Sandler, 2000). Hence, all rebel groups need to pay a tax to group G. As a redistribution, there is a policy vector $y = \{y_1, y_2, ..., y_n\}$ proposed by the government (group G), which is the transfer or compensation given to each rebel group. We describe the game as follows:

Stage 1: Initially each group possesses a resource, R_G for group G and R_i for group P_i (i = 1, 2, . . . , n). Group G proposes policy $y_i > 0$ (i = 1, 2, . . . , n) to each potential rebel

group, each rebel group P_i chooses independently and simultaneously to accept the policy and remain in peace or rebel to start a civil war.

Stage 2: If any group P_i ($i \in \{1,2,\ldots,n\}$) accepts the proposal, then y_i is transferred from group G to group P_i, and each group P_i pays a tax T_i to Group G [1]. If group P_i chooses to rebel, civil war happens and y_i is not transferred. Group P_i succeeds with probability q_i [2]. The outcomes of rebellion will be: if group P_i wins, it refuses to pay the tax T_i; if it loses, it will still need to pay the tax. Both sides occur a cost of war, C_G for group G and C_i for group P_i.

Figure. 3.2 *Second Stage of Basic Model*



We solve the game by backward induction:

[1] The tax is assumed to be much less than the available resource ($T_i < R_i - C_i$) thus the net amount would not be negative.

[2] The probability of victory is decided by the contest success function and depends on the military capacity of both sides. This will be discussed in the next section where we will use it to find optimal military spendings and payoffs at equilibrium. In the basic model, whether this probability is endogenous or not will not affect the analysis of equilibrium.

i. Action of Group P_i:

The expected payoffs of any rebel group P_i (i = 1, 2, . . . , n) at the end of second stage will be:

$$E_i(Accept) = R_i - T_i + y_i$$

$$E_i(Rebel) = q_i * R_i + (1 - q_i) * (R_i - T_i) - C_i$$

If $E(Accept) \geq E(Rebel)$, group P_i will accept the policy and remain in peace. We then have

$$y_i \geq q_i T_i - C_i$$

i.e. the minimum y_i that group P_i is willing to accept, is

$$y_i^* = q_i T_i - C_i \tag{3.1}$$

Hence, to avoid war and maximize the profit, the total amount group G could propose will be

$$\sum y_i^* = \sum (q_i T_i - C_i) \tag{3.2}$$

ii. Action of Group G:

The group G is now facing two strategies: proposing exactly y_i^* to avoid war, or proposing nothing so civil war occurs. The expected payoffs of group G at the end of second stage will be:

$$C_G(Propose) = R_G + \sum T - \sum y^*$$

$$C_G(Not) = R_G + \sum T - \sum y^* + y_i^* - q_i * T_i - C_G$$

We can show that $E(Propose) \geq E(Not)$ since $C_G \geq 0$ and $C_i \geq 0$. In other words, as long as the costs of war are non-negative, group G cannot profit from civil war. There will be no civil war, as all groups reach peaceful settlements.

Proposition 3.1. *Under complete information, civil war does not occur, the only Nash equilibrium is that the government proposes a certain amount of transfers ($y^* = \{y_1^*, y_2^*, ..., y_n^*\}$), which are the minimum that can prevent all rebel groups from rebellion, and all rebel groups will accept them.*

At equilibrium, the payoff of group G will be

$$U_G = R_G + \sum T - \sum y^*$$

, and the payoffs of rebel groups P_i (i = 1, 2, . . . , n) will be

$$U_i = R_i - T_i + y_i^*$$

Substituting in equation (3.1) and (3.2), we have

$$U_G = R_G + \sum (1 - q_i) T_i + \sum C_i$$

$$U_i = R_i - (1 - q_i) T_i - C_i$$

The results of bargaining show that military outcomes reflect the balance of opposing forces (Konrad and Skaperdas, 1998), as groups' payoffs at the equilibrium are determined by the probabilities of victory for the rebel groups (q_i). The higher winning probability reduces the loss of the rebel group, and reduces the gain of the government. Moreover, the final payoffs also depend on the costs of rebellion for the rebel groups (C_i) rather than the defending cost for the government (C_G). The existence of rebellion costs benefits the government in the bargaining.

3.4 Coalition with Endogenous Military Input

Most models in previous literature assume just two actors in conflicts. Civil wars are seldom so simple. Societies divide along multiple lines - by class, geography, religion, or ethnicity (Ray, 2009). While this is often true, it has been pointed out that the number of potential rebel groups may not be given exogenously. We want to analyse the question of whether rebel groups will form a coalition to implement a joint course of action and initiate violent conflict against the central government.

We start with the case where there are only two potential rebel groups (n=2), P_1 and P_2. The question is studied by comparing the final expected payoffs for the two rebel groups between the choices of forming and not forming a coalition.

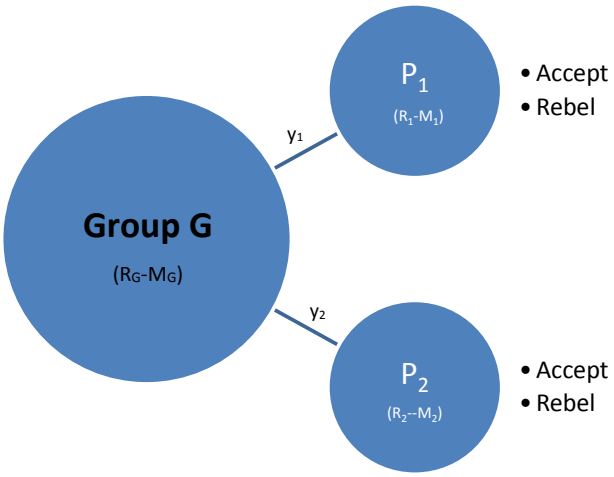
We extend the basic model by assuming an input as defence spending is decided at the

beginning of the game. Each group invests part of their resources in military expenditure (guns) - M_G for group G and (M_1, M_2) for the two rebel groups, which will be deducted from total resources [3]. Hence, at the end of first stage, or at the beginning of second stage, the available resource for the government would be $R_G - M_G$, and the available resources for the the two rebel groups would be $(R_1 - M_1, R_2 - M_2)$.

i. Payoffs with No Coalition:

Without forming a coalition, the basic model between one central government and two rebel groups is shown by Figure 3.3.

Figure. 3.3 *Second Stage of Basic Model with Military Input and No Coalition*



[3]We did not assume endogenous defence spending in the basic model because it will not affect the characterisation of equilibrium.

Similar to the basic model, using backward induction, we can solve the payoff functions at equilibrium for each group as follow

$$U_G = R_G - M_G + \sum(1-q_i)T_i + \sum C_i \qquad \text{i=1,2} \tag{3.3}$$

$$U_1 = R_1 - M_1 - (1-q_1)T_1 - C_1 \tag{3.4}$$

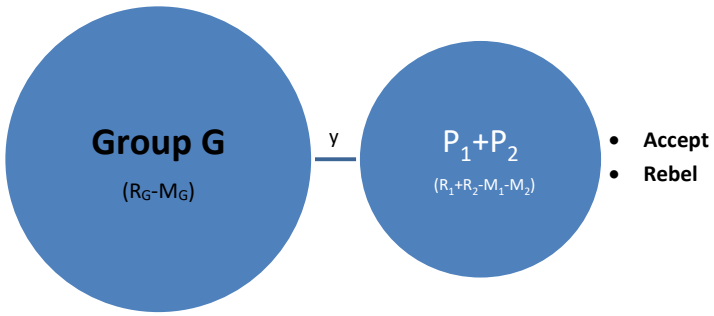
$$U_2 = R_2 - M_2 - (1-q_2)T_2 - C_2 \tag{3.5}$$

We can see that in this example, the only difference with the basic model is that there is a military expense deducted from the original resources of each group. We will compare the rebel groups' payoffs, U_1 and U_2, with their payoffs after forming a coalition which will be discussed next.

ii. Payoffs with Coalition:

If the two groups form a coalition, the model between the government and the coalition becomes

Figure. 3.4 Basic Model with Military Input and Coalition



The winning probability of the coalition is denoted as q_{12}. The total resources of the coalition would be $R_{12} = R_1 + R_2$. The total military expenditure of the coalition would be $M_{12} = M_1 + M_2$. The total tax paid by the coalition is $T_{12} = T_1 + T_2$. The total war cost of the coalition is $C_{12} = C_1 + C_2$. Using backward induction, the total payoffs of the coalition at equilibrium would be

$$U_{12} = R_{12} - M_{12} - (1 - q_{12})T_{12} - C_{12} \tag{3.6}$$

To compare the payoffs as above, we follow the work by Garfinkel and Skaperdas (2007), who model conflict as a contest game in which inputs on arming decide winning probabilities. The most common form of contest success function takes the following additive form:

$$q_i = P(M_G, M_i) = \begin{cases} \frac{f(M_i)}{f(M_i)+f(M_G)} & \text{if} \quad f(M_i) + f(M_G) > 0 \\ \frac{1}{2} & \text{otherwise,} \end{cases}$$

where f(.) should be a non-negative, increasing function. To simplify the model, we use the following functional form for the contest success function:

$$q_i = \frac{M_i}{M_i + M_G}$$

Hence, the probabilities of victory for group P_1 and P_2 if they don't form a coalition will be

$$q_1 = \frac{M_1}{M_1 + M_G} \quad \text{and} \quad q_2 = \frac{M_2}{M_2 + M_G}$$

Accordingly, the probabilities of victory for the coalition will be

$$q_{12} = \frac{M_{12}}{M_{12} + M_G} = \frac{M_1 + M_2}{M_1 + M_2 + M_G}$$

We can prove that $q_{12} > q_1$ and $q_{12} > q_2$, therefore

$$U_{12} > U_1 + U_2$$

The same can be applied to the multiple-group case: when the grand coalition is denoted as $N = \{1, 2, ..., n\}$, the winning probability of the coalition is

$$q_N = \frac{M_N}{M_N + M_G} = \frac{\sum M_i}{\sum M_i + M_G}$$

At equilibrium, the payoff function of the grand coalition will be

$$U_N = \sum R_i - \sum M_i - (1 - q_N) \sum T_i - \sum C_i$$

Again, as $q_N > q_i$, we have the total payoff of the grand coalition is higher than the sum of the payoffs of all rebel groups if they do not form a coalition: $U_N > \sum U_i$ where $U_i = R_i - M_i - (1 - q_i)T_i - C_i$.

Proposition 3.2. *Forming a coalition can improve the total welfare for rebel groups by increasing their winning probability, and thus their bargaining power.*

3.4.1 Fighting within Coalition

Next we consider the possibility that, even after the welfare is improved by forming a coalition, rebel groups can fight with each other and whether that would affect their decision to form a coalition in the first place.

If we assume the groups fight for the extra earnings ($U_{12} - U_1 - U_2$), then no matter how they divide the extra earnings between each other their final payoffs are better than, or at least equal to, their payoffs if they do not form a coalition. Hence, both rebel groups have the incentives to form a coalition. The same reasoning can be applied to the multiple-group case, which implies that if the rebel groups are not politically exclusive they will eventually become one big group to go against the government.

If we assume the fight between groups follows the winner-take-all rule, we have a Tullock contest, and each side receives its share of the total payoff (U_{12}) based on its own military capability as well as other's. In the case of two rebel groups, their final payoffs will be

$$V_1 = \frac{M_1}{M_1 + M_2} U_{12}$$

$$V_2 = \frac{M_2}{M_1 + M_2} U_{12}$$

where U_{12} is defined in equation (3.6). The two groups will only be willing to form a coalition if and only if

$$V_1 \geq U_1 \quad \text{and} \quad V_2 \geq U_2 \tag{3.7}$$

Since each group seeks to maximize its payoff, we solve the first order conditions for equations (3.3)-(3.5): $\frac{\partial U_G}{\partial M_G} = 0$, $\frac{\partial U_1}{\partial M_1} = 0$, and $\frac{\partial U_2}{\partial M_2} = 0$ to find the optimal military inputs (See Appendix C.1). And we have

$$M_G^* = M_1^* + M_2^*$$

At equilibrium, the optimal military input of the government equals the sum of the inputs of all rebel groups which are

$$M_1^* = \frac{1}{9}(\sqrt{T_1 T_2} + 2T_1 - T_2)$$
$$M_2^* = \frac{1}{9}(\sqrt{T_1 T_2} + 2T_2 - T_1)$$

Substitute them into conditions (3.7), and we have the conditions for the rebel groups to form a coalition:

$$[R_1 - C_1 + R_2 - C_2 - \frac{1}{2}(T_1 + T_2)]\lambda \geq R_1 - C_1 - K_1 \tag{3.8}$$
$$[R_1 - C_1 + R_2 - C_2 - \frac{1}{2}(T_1 + T_2)]\lambda \leq R_1 - C_1 - \frac{1}{2}(T_1 + T_2) + K_2 \tag{3.9}$$

where λ is the share of rebel group P_1 in coalition: $\lambda = \frac{M_1^*}{M_1^* + M_2^*}$; K_1 and K_2 are parameters: $K_1 = \frac{1}{3}\sqrt{T_1}(\sqrt{T_1} + \sqrt{T_2})$, $K_2 = \frac{1}{3}\sqrt{T_2}(\sqrt{T_1} + \sqrt{T_2})$.

If the initial resources and war costs are considered to be exogenous, which is normally reasonable to assume, the above conditions are related to the taxes (T_1 and T_2) that are

supposed to be paid by the rebel groups. We then consider the possible interpretations:

i. Symmetric Situation

Let's start with the symmetric situation when the taxes for each group are the same: $T_1 = T_2 = T$. The two conditions become

$$(R_1 - C_1) - (R_2 - C_2) \leq \frac{1}{3}T$$
$$(R_2 - C_2) - (R_1 - C_1) \leq \frac{1}{3}T$$

This is identical to $|(R_1 - C_1) - (R_2 - C_2)| \leq \frac{1}{3}T$, which implies that as long as the difference between the available resources of two rebel groups is small enough, they will form a coalition, as their total payoffs will be improved. The increase of the tax T causes the conditions to be more likely to be satisfied. Thus, raising the tax incentivises the formation of a coalition.

ii. Tax Raising on One Side (Asymmetric Situation)

Now suppose only T_1 is increased. As calculated previously, M_1^* will be increased, which means rebel group P_1 will spend more on its military input; while group P_2 decreases its military expenditure M_2^* as long as its tax is not extremely high compared with the other group ($T_2 < 4T_1$). As a result, group P_1's share in the coalition λ will be increased.

This, intuitively, should increase group P_1's incentive to form a coalition, but has the opposite effect on group P_2. That is also proved by rearranging conditions (3.8) and

(3.9). Similarly, raising T_2 increases group P_2's incentive to form a coalition, and does the opposite to group P_1. (See Appendix C.1)

Proposition 3.3. *In the model that allows a Tullock contest within the coalition after a joint course of action, both symmetric and asymmetric rise in tax increase the incentive for rebel groups to form a coalition.*

Remark. As an extension of the basic model, no civil war happens in equilibrium no matter whether a coalition is formed or not. The rise in tax increases the rebel's military input, hence increases its share in the coalition, which provides the incentive for it to form a coalition while it has the opposite effect on its opponent.

3.5 Commitment Problem

The most intriguing theories of civil war focus on the cases where credible commitments to peace or redistribution cannot be made even with complete information, that is, when at least one side faces an incentive to renege once a settlement is reached (Walter, 1997). The commitment problem suggests that when there are limits to conflict resolution and contract enforcement, civil war is more likely to occur. This applies to many aspects of agreements, including promises to make future transfers or not to attack in the future.

In some cases, an outside authority, for instance an international organization, can serve

as an enforcer of an agreement. However, in the case of intra-state conflict, the outside authority may not be able to play an effective role. Hence for an agreement to endure it has to be balanced in such a way as to be self-enforcing. A self-sustaining agreement requires the costs of war subsequent to any transfers of wealth or territory to be overwhelmingly high, so that war becomes non-beneficial in expectation. Another interpretation could be that by giving up some resources the target becomes less attractive, or a less threatening adversary.

In the commitment case, a potential rebel group compares the value of no war (their wealth plus any transfers) to what they would gain from a war in the absence of any transfers; while in the no-commitment case a potential rebel group compares the value of no war (their wealth plus any transfers) to what they would gain from a war after transfers have been made. (Jackson and Morelli, 2007)

3.5.1 Model with Commitment Problem

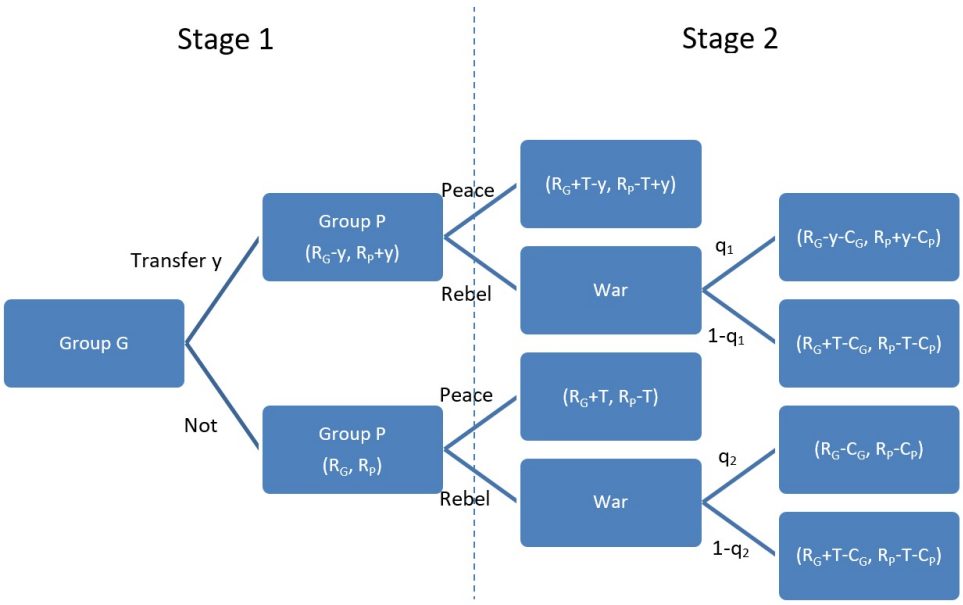
The basic model between central government (group G) and one potential rebel group (group P) is modified to be that the government can choose whether to make the transfer or not, and the rebel group, after receiving the transfer, can still choose to rebel or stay at peace. Figure 3.5 presents the extensive form of the game.

Group G has two strategies at the first stage: (Transfer, Not transfer). Group P will have four strategies, denoted as (AA, AR, RA, RR). 'AA' represents that it stays at peace no matter whether or not the transfer is made. Similarly, 'RR' represents that group P

always rebels. 'AR' represents it stays at peace if the government transfers but rebels if there is no transfer. 'RA' is the other way around. When rebellion happens, both sides incur the costs of war - C_G for group$G$ and C_P for group$P$.

If group G decides to make the transfer, y is transferred from group G to group P at the first stage. Group P wins with probability q_1 after receiving transfer y, with probability q_2 if no transfer is made ($q_1 > q_2$ as transfer makes the rebel stronger). Consistent with the basic model, if group P wins, it refuses to pay the tax T; if it loses, it will still need to pay the tax.

Figure. 3.5 *Extensive Form of Model with Commitment Problem*



The difference with the basic model is that, without commitment, rebellion can occur after a transfer is made. We assume this transfer is only taken back when group P loses the war (when group P wins, it can keep the transfer).

Figure 3.6 shows the normal form. Payoffs in Figure 3.6 are structured as (Group C's payoff, Group Pi's payoff). The payoffs in terms of the strategy which is the best response against the adversary's strategy are underlined: if the rebel group will stay at peace or rebel no matter what ('AA', 'RR'), the best response of government is not to transfer. We will discuss possible equilibria.

Figure. 3.6 *Normal Form of Model with Commitment Problem*

Group P / **Group G**	AA	AR	RA	RR
Transfer y	R_G+T-y, R_P-T+y	R_G+T-y, R_P-T+y	$q_1(R_G-y)+(1-q_1)(R_G+T)-C_G$, $q_1(R_P+y)+(1-q_1)(R_P-T)-C_p$	$q_1(R_G-y)+(1-q_1)(R_G+T)-C_G$, $q_1(R_P+y)+(1-q_1)(R_P-T)-C_p$
Not	$\underline{R_G+T}$, R_P-T	$q_2R_G+(1-q_2)(R_G+T)-C_G$, $q_2R_P+(1-q_2)(R_P-T)-C_p$	R_G+T, R_p-T	$\underline{q_2R_G+(1-q_2)(R_G+T)-C_G}$, $q_2R_P+(1-q_2)(R_P-T)-C_p$

i. Civil War as Equilibrium

With the commitment problem, we know that if the rebel group will rebel no matter what ('RR'), the best response of government is not to transfer. On the other hand, given group *G* does not transfer, if the payoff of rebel group from rebellion is higher than the payoff from staying at peace: $E_P(AR) = E_P(RR) > E_P(AA) = E_P(RA)$, the result (Not, RR) is always an equilibrium (Highlighted in Figure 3.7).

Figure. 3.7 *Civil War as Equilibrium*

Group P **Group G**	AA	AR	RA	RR
Transfer y	R_G+T-y, R_P-T+y	R_G+T-y, R_P-T+y	$q_1(R_G\text{-}y)+(1-q_1)(R_G+T)$ -C_G, $q_1(R_P+y)+(1-q_1)(R_P\text{-}T)$-$C_p$	$q_1(R_G\text{-}y)+(1-q_1)(R_G+T)$ -C_G, $q_1(R_P+y)+(1-q_1)(R_P\text{-}T)$-$C_p$
Not	R_G+T, R_P-T	$q_2R_G+(1\text{-}q_2)(R_G+T)$-$C_G$, $q_2R_P+(1-q_2)(R_P\text{-}T)$-$C_p$	R_G+T, R_p-T	$q_2R_G+(1\text{-}q_2)(R_G+T)$-$C_G$, $q_2R_P+(1-q_2)(R_P\text{-}T)$-$C_p$

Solve the condition, we have

$$q_2R_P + (1-q_2)(R_P - T) - C_P \geq R_P - T$$

$$C_P \leq q_2T \tag{3.10}$$

Since group G will not transfer and group P always chooses to rebel, civil war occurs. The left hand side of condition (3.10) is the cost of war for the rebel group P. At the right hand side, q_2 is the probability of victory for the rebel group when there is no transfer.

Hence, if the cost of war is small enough or the winning probability of the rebel group is big enough, the government would not propose anything and the rebel group would choose to rebel. Civil war is always a Nash equilibrium.

The intuition is that both government and rebel group cannot convince the other that they will fulfil the non-aggressive agreement, knowing they will enter a period of intense vulnerability. And so, no settlement will be achieved and civil war occurs (Walter, 1997). Empirically, civil war is found to be more common in low-income countries. Much of

the literature suggests that low income is often associated with low opportunity cost of fighting (Collier and Hoeffler, 1998, 2004; Collier et al., 2009). Proposition 3.4 shows that low cost of war leads to high probability of rebellion, and hence explains the frequent internal conflict in low-income countries.

ii. Settlement as Equilibrium

If the government prefers the rebel group to accept the proposal because its payoff from settlement is bigger than the expected payoff from war:

$$E_G(Transfer,AA) = E_G(Transfer,AR) > E_G(Not,AR) = E_G(Not,RR)$$

, we can solve

$$R_G + T - y > q_2 R_G + (1 - q2)(R_G + T) - C_G$$

and get

$$y < q_2 T + C_G \tag{3.11}$$

As long as inequality (3.11) is satisfied, group G has an incentive to make an optimal transfer and improve its profit.

Given that group G makes the transfer y, rebel group P will stay at peace if and only if its payoffs are bigger than the expected payoffs from rebellion:

$$E_P(AA|Transfer) = E_P(AR|Transfer) \geq E_P(RA|Transfer) = E_P(RR|Transfer)$$

We solve

$$R_P - T + y \geq q_1(R_P + y) + (1 - q_1)(R_P - T) - C_P$$

and get

$$y \geq \frac{q_1 T - C_P}{1 - q_1}$$

i.e. the minimum transfer that can prevent group P from rebellion is

$$y^* = \frac{q_1 T - C_P}{1 - q_1}$$

To make y^* preferable for group G to make the transfer, it needs to satisfy condition (3.11):

$$y^* = \frac{q_1 T - C_P}{1 - q_1} < q_2 T + C_G$$

Hence, we have

$$(q_1 - q_2 + q_1 q_2)T < C_P + (1 - q_1)C_G \tag{3.12}$$

Even if condition (3.10) is satisfied, which means the war cost of rebel group (C_P) is small so that civil war is an equilibrium, as long as the government expect the cost of war (C_G) to be big enough, condition (3.12) makes sure the government cannot profit from civil war, so a transfer y^* will be made and rebel group will stay at peace. The result (Transfer, AR) become another equilibrium (Highlighted in Figure 3.8).

Figure. 3.8 *Settlement as Equilibrium*

Group P / **Group G**	AA	AR	RA	RR
Transfer y	R_G+T-y, R_P-T+y	R_G+T-y, R_P-T+y	$q_1(R_G\text{-}y)+(1-q_1)(R_G+T)$ -C_G, $q_1(R_P+y)+(1-q_1)(R_P\text{-}T)$-$C_p$	$q_1(R_G\text{-}y)+(1-q_1)(R_G+T)$ -C_G, $q_1(R_P+y)+(1-q_1)(R_P\text{-}T)$-$C_p$
Not	R_G+T, R_P-T	$q_2R_G+(1-q_2)(R_G+T)$-C_G, $q_2R_P+(1-q_2)(R_P\text{-}T)$-$C_p$	R_G+T, R_p-T	$q_2R_G+(1-q_2)(R_G+T)$-C_G, $q_2R_P+(1-q_2)(R_P\text{-}T)$-$C_p$

Proposition 3.4. *While a commitment problem might result in the outbreak of civil war, a settlement can still be achieved as equilibrium if the defending cost of the government is sufficiently high.*

We can see that both equilibria are highly related to the war cost of either side [4]. The optimal transfer in the model with commitment problem ($y^* = \frac{q_1 T - C_P}{1-q_1}$) is bigger than the transfer in the basic model (See equation (3.1)). Hence, commitment problem causes a more disadvantaged position for the government in our model while also raising the possibility that civil war will occur.

3.5.2 Repeated Game Model

Previously we have identified that civil war and settlement can both happen at equilibrium. If we consider the previous game is played more than once, this suggests, in the long run, either war or negotiated settlement can happen in turn as equilibrium. As reported by Leventoğlu and Slantchev (2007), almost 70 percent of conflicts end with a negotiated

[4] Similar intuition can be seen in Gupta (2007, 2012), where the effect of opportunity cost on the nature of independence movement is found.

settlement, and almost no conflict ends with the complete elimination of one side. Thus, we need to explain how the commitment problem disappears and a self-enforcing settlement becomes feasible over time.

We analyse the question by considering the repeated game model as an extension of our previous model. As we have seen, the risk of civil war always exists unless the internal conflict ends with a complete secession. Hence, we propose the game with commitment problem is played infinitely. To make settlement: (Transfer, AR) a preferable outcome, we need both groups' expected payoffs from peaceful agreement to be bigger than the payoffs from civil war: $E_G(Tranfer,AR) > E_G(Not,RR)$ and $E_P(Transfer,AR) > E_P(Not,RR)$. So we have

$$q_2T - C_P < y < q_2T + C_G$$

To maximize the payoff, group G will propose slightly higher than $q_2T - C_P$. This transfer is smaller than the optimal proposal y* when the game is only played once ($y^* = \frac{q_1T - C_P}{1-q_1}$) because $q_1 > q_2$, so we have a 'prisoner dilemma' as the rebel group will prefer the outcome of rebellion with this transfer. Next we will show the condition under which the preferable settlement can be maintained and no group will deviate to start the civil war. Let's consider a trigger strategy as follows:

a. At the beginning, both groups start with playing "Cooperate", that is, group G makes the transfer and rebel group P stays at peace.

b. If any group deviates to "Non-cooperate" (group G does not transfer, or group P rebels), the other group will punish by playing "Non-cooperate" in next period.

c. Punishment lasts for one period, and then both groups go back to play "Cooperate".

Future payoffs for both groups are discounted at rate $\delta \in [0,1]$.

i. Action of Group P:

If group P always plays "Cooperate", its total payoff in all periods will be

$$E_i(Cooperate) = R_P - T + y + \delta(R_P - T + y) + \delta^2(R_P - T + y) + ...$$

If group P deviates to rebel at the first period, it will be punished in the second period and then move back to the 'cooperative' equilibrium. Its total payoff will be

$$E_i(Rebel) = [q_1(R_P + y) + (1 - q_1)(R_P - T) - E_P] + \delta[q_2 R_P + (1 - q_2)(R_P - T) - E_P] + \delta^2(R_P - T + y) + \delta^3(R_P - T + y) + ...$$

The rebellion will not happen if $E_i(Cooperate) \geq E_i(Rebel)$. We solve and have

$$y \geq \frac{(q_1 + \delta q_2)T - (1 + \delta)C_P}{1 - q_1 + \delta}$$

Hence, the minimum transfer that prevent group P_i from rebellion is

$$y^* = \frac{(q_1 + \delta q_2)T - (1 + \delta)C_P}{1 - q_1 + \delta}$$

ii. Action of Group P_G:

Group G has no incentive to deviate from cooperation (change from 'Transfer' to 'Not

transfer') as $E_G(Tranfer, AR) > E_G(Not, RR) = E_G(Not, AR)$. So y^* needs to satisfy that:

$$\frac{(q_1 + \delta q_2)T - (1+\delta)C_P}{1 - q_1 + \delta} < q_2 T + C_G$$

Rearrange it, and we have

$$(q_1 - q_2 + q_1 q_2)T < C_P + (1 - q_1)C_G + \delta(C_P + C_G) \tag{3.13}$$

In the long term, a settlement can be maintained if condition (3.13) is satisfied. As the groups become more patient, δ increases, condition (3.13) is more likely to be satisfied.

Proposition 3.5. *The more patient both groups are, the more likely a peaceful settlement can be maintained in the long run.*

If the groups are not patient at all, $\delta = 0$, the optimal transfer becomes $y^* = \frac{q_1 T - C_P}{1 - q_1}$, which is exactly the optimal transfer when the game is played once; and condition (3.13) becomes the same as condition (3.12). Hence, condition (3.12) is a special case of the repeated model when groups do not care about future. As δ increases, y^* becomes smaller ($\frac{\partial y^*}{\partial \delta} < 0$). This can be interpreted as that, since the rebel group cares more about future payoffs, the possible punishment in the next period reduces its incentive to rebel and thus weakens its bargaining power.

3.6 Conclusion

The prevention of civil war has always being one of the important aspects of the research into conflict. This chapter provides a detailed understanding on the occurrence of rebellion, including the forming of a coalition, and how exactly the commitment issue influences the reaching of an agreement and a self-sustaining settlement in the long term.

Consistent with previous chapters, our theoretical framework is based on a bargaining conflict model. However, unlike international wars, a different model-setting is designed to study potential rebellions. The conflict between government and rebel groups is over particular domestic issues such as taxation (or any other kinds of exploitation) and redistribution (domestic policies).

Our model considers the situation where potential rebels fight for their rights of not being exploited. The Nigerian Civil War (6 July 1967 – 15 January 1970) is an example. The war was fought between the government of Nigeria and the secessionist state of Biafra. Although the conflict resulted from political, economic, ethnic, cultural and religious tensions, control over the lucrative oil production in the Niger Delta played a vital strategic role. The central government had attempted to occupy the region with the discovery of oil reserves, which fuelled Igbo fears that the oil would only be used to benefit the North (Uche, 2008). Our model discusses, to what extend, economic factors affect the initiation of civil war.

As expected, the outcomes of bargaining reflect the balance of military forces. In terms of the formation of coalition, we show that by forming a coalition the total payoff of rebel groups is improved due to the increase of bargaining power. This has provided incentives for groups that are not politically exclusive to gather together and become one big group. However, if we allow the groups to fight within the coalition, the incentives for rebel groups to form a coalition increase with the tax that they are asked to pay. Heavy taxation could cause the coalition on the rebel group side to be more likely.

We present a model in which both sides cannot credibly commit to agreement and propose two conclusions: when the war costs of rebel group are small enough civil war is an equilibrium, as 'non-cooperation' is the best response to each other. Our results are consistent with previous empirical studies as in previous studies low-income country is found to be more likely to suffer civil war, and this could be because low income is associated with low opportunity cost (Collier and Hoeffler, 1998, 2004; Collier et al., 2009). At the same time, if the war costs of the government are high enough the central government is motivated to make a transfer and prevent the rebellion. To maintain this settlement in the long term, the same condition needs to be satisfied taking discounted future value into account. The more the rebel group values the future, the more disadvantaged the position for the rebel group is found to become. In general, our results support that civil war can be avoided by making the costs of war sufficiently high for both sides.

Conclusions and Future Directions

The economic analysis of conflict has led us to a more comprehensive understanding of the origins of war. While there are well-developed empirical studies of the various causes of war, this thesis complements these empirical studies by developing theoretical models to understand when war occurs.

First, the basic two-country bargaining model reveals that war is essentially inefficient, as rational agents with complete and consistent information would prefer a peaceful settlement rather than costly war. When incorporating the model with non-transferable benefits, the analysis shows a non-monotone relationship between relative wealth level (wealth of targeted country/ wealth of aggressive country) and the likelihood of conflict escalation, which suggest that rich states are not necessarily less war-prone unless they expect the costs of war outweigh the gains.

Second, a democracy is found to be more aggressive when its expected probability of victory in war is high. In contrast, the low frequency of war between democracies could be explained by a low expectation of this probability when they confront each other. Although the fact that most democracies are well developed might be able to support the argument,

further study on whether democracies do indeed have low expected winning probabilities in potential war against each other is still needed.

Third, our analysis of rebellion shows that although the outcomes of bargaining reflect the balance of military forces as expected, the theory of feasibility is more crucial than motivation in explaining the outbreak of civil war, since the costs of war are identified to be the key elements in the conditions which determine the failure to reach a settlement. Therefore, the prevention of civil war is achieved by making it militarily and financially infeasible.

Nonetheless, the causes of war are complicated. There are many other factors that could influence its outbreak. Moreover, the shortage of theoretical analysis remains an unsolved problem until a well-specified theory is combined with sufficient case studies. Hence, further study will be needed in order to gain a richer understanding of the origins of wars and to help in identifying more frequent and important causes since, ultimately, the aim will be to avoid the costs of conflict.

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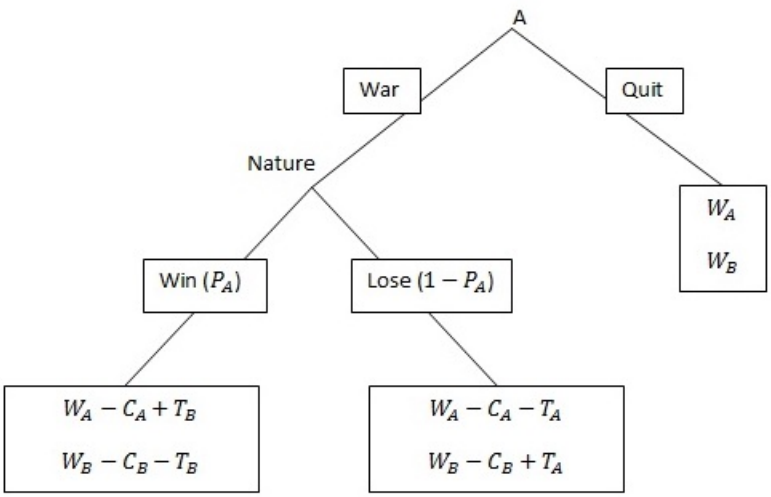
Appendix A

A.1 Analysis for Basic Model

Using backward induction, in the subgame shown by Figure A1, country A need to choose between starting a war (*War*) or giving up (*Quit*).

Figure. A.1 *Subgame*



The expected payoffs for country A would be

$$E_A(Quit) = W_A$$

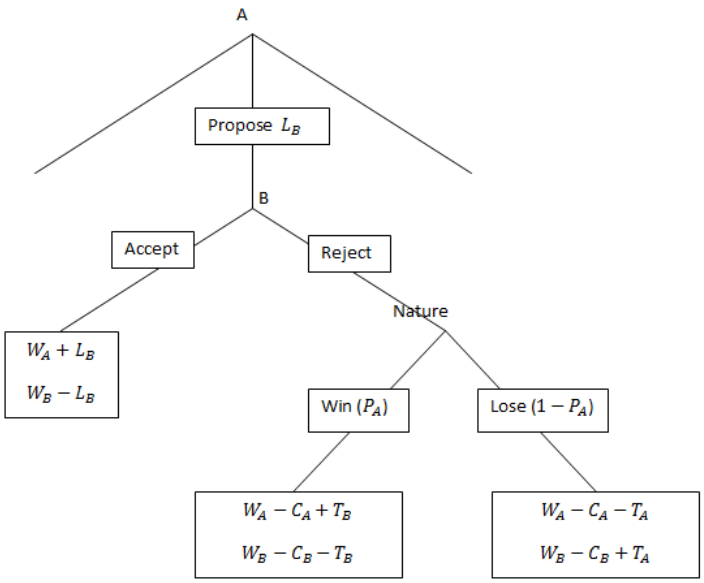
$$E_A(War) = P_A(W_A - C_A + T_B) + (1 - P_A)(W_A - C_A - T_A)$$

It will choose to go war if the expected payoff of starting a war is bigger than the payoff of giving up: $E_A(Quit) < E_A(War)$. We solve and get

$$P_A > \frac{C_A + T_A}{T_A + T_B}$$

Assuming above inequality is satisfied, country A will definitely go to war in the subgame. Then the game can be simplified as follow:

Figure. A.2 *Simplified Game*



Country B will choose between $Accept$ or $Reject$. Its expected payoffs would be

$$E_B(Accept) = W_B - L_B$$

$$E_B(Reject) = P_A(W_B - C_B - T_B) + (1 - P_A)(W_B - C_B + T_A)$$

If $E_B(Accept) \geq E_B(Reject)$, we have

$$L_B \leq P_A(T_A + T_B) - T_A + C_B$$

Country B will accept the proposal. Hence, the maximum that country B will accept would be

$$maxL_B = P_A(T_A + T_B) - T_A + C_B$$

A.2 Breusch-Pagan LM test for random effects versus OLS

Test 1: *Breusch-Pagan LM test for random effects versus OLS*

```
war[id,t] = Xb + u[id] + e[id,t]

Estimated results:
```

	Var	sd = sqrt(Var)
war	.2158478	.4645942
e	.1828783	.4276427
u	.0177815	.1333472

```
Test:   Var(u) = 0

                     chibar2(01) =    21.49
                  Prob > chibar2 =   0.0000
```

A.3 Hausman test for fixed versus random effects model

Test 2: *Hausman test for fixed versus random effects model*

	Coefficients			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
RE	.3332159	.243982	.0892339	.0821564
RE2	-.0120737	-.0090676	-.0030061	.0039386
demdem	-.3255575	-.6281818	.3026243	.5161406
MajorPower	-.3468561	-.4321451	.0852891	.7111865
Nonaggression	-1.291772	-.2286748	-1.063098	.4431311
DirCon	.3933366	-.1023216	.4956582	.657281
DeploEx	.1035266	.0503609	.0531657	.2542038
MilitaryBalance	.9695979	.1282432	.8413547	.2910823

b = consistent under Ho and Ha; obtained from xtlogit

B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

chi2(8) = (b-B)´[(V_b-V_B)^(-1)](b-B)

= 14.37

Prob>chi2 = 0.0725

A.4 Overidentification test after IV regression

Test 4: *Overidentification test after IV regression*

```
Test of overidentifying restrictions:
Cross-section time-series model: xtivreg g2sls  robust cluster(id)
Sargan-Hansen statistic   4.102  Chi-sq(3)    P-value = 0.2507
```

```
Instrumented:         RE RE2 demdem
Included instruments: MajorPower Nonaggression DirCon DeploEx MilitaryBalance
Excluded instruments: RE_1 RE_12 demdem_1 RE_5 RE_52 demdem_5
Dropped collinear:    Lndist
```

Appendix B

B.1 Analysis for 2.3.1 Democracy vs. Democracy

Using the backward induction, in the subgame country A will choose to go to war if the expected payoff of starting a war is bigger than the payoff of giving up: $E_A(Quit) < E_A(War)$.

$$E_A(Quit) = (1-\alpha_A)W_A + \alpha_A Q_A^Q R$$

$$E_A(War) = P_A[(1-\alpha_A)(W_A - C_A + T_B) + \alpha_A Q_A^W R] + (1-P_A)[(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A Q_A^D R]$$

We solve and get

$$P_A > \frac{(1-\alpha_A)(C_A + T_A) + \alpha_A(Q_A^Q - Q_A^D)R}{(1-\alpha_A)(T_A + T_B) + \alpha_A(Q_A^W - Q_A^D)R}$$

And when the above inequality is satisfied, country B will accept A's proposal if $E_B(Accept) \geq E_B(Reject)$.

$$E_B(Accept) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

$$E_B(Reject) = P_A[(1-\alpha_B)(W_B - C_B - T_B) + \alpha_B Q_B^D R] + (1-P_A)[(1-\alpha_B)(W_B - C_B + T_A) + \alpha_B Q_B^W R]$$

We solve and get

$$S \leq P_A(T_A + T_B) - T_A + C_B - \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A)Q_B^W + P_A Q_B^D]R - Q_B^L R\}$$

Hence, the maximum that country B will accept would be

$$S^* = P_A(T_A + T_B) - T_A + C_B - \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A)Q_B^W + P_A Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

B.2 Analysis for 2.3.2 Democracy vs. Autocracy

Using the backward induction, in the subgame country A will choose to go to war if the expected payoff of starting a war is bigger than the payoff of giving up: $E_A(Quit) < E_A(War)$.

$$E_A(Quit) = (1-\alpha_A)W_A + \alpha_A Q_A^Q R$$

$$E_A(War) = P_A[(1-\alpha_A)(W_A - C_A + T_B) + \alpha_A Q_A^W R] + (1-P_A)[(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A Q_A^D R]$$

We solve and get

$$P_A > \frac{(1-\alpha_A)(C_A+T_A) + \alpha_A(Q_A^Q - Q_A^D)R}{(1-\alpha_A)(T_A+T_B) + \alpha_A(Q_A^W - Q_A^D)R}$$

And when the above inequality is satisfied, country B will accept A's proposal if $E_B(Accept) \geq E_B(Reject)$.

$$E_B(Accept) = (1-\alpha_B)(W_B - S) + \alpha_B R$$

$$E_B(Reject) = P_A(1-\alpha_B)(W_B - C_B - T_B) + (1-P_A)(1-\alpha_B)(W_B - C_B + T_A) + \alpha_B R$$

We solve and get

$$S \leq P_A(T_A+T_B) - T_A + C_B$$

Hence, the maximum that country B will accept would be

$$S^* = P_A(T_A+T_B) - T_A + C_B$$

B.3 Analysis for 2.3.2 Autocracy vs. Democracy

Using the backward induction, in the subgame country A will choose to go to war if the expected payoff of starting a war is bigger than the payoff of giving up: $E_A(Quit) < E_A(War)$.

$$E_A(Quit) = (1-\alpha_A)W_A + \alpha_A R$$

$$E_A(War) = P_A(1-\alpha_A)(W_A - C_A + T_B) + (1-P_A)(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A R$$

We solve and get

$$P_A > \frac{C_A + T_A}{T_A + T_B}$$

And when the above inequality is satisfied, country B will accept A's proposal if $E_B(Accept) \geq E_B(Reject)$.

$$E_B(Accept) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

$$E_B(Reject) = P_A[(1-\alpha_B)(W_B - C_B - T_B) + \alpha_B Q_B^D R] + (1-P_A)[(1-\alpha_B)(W_B - C_B + T_A) + \alpha_B Q_B^W R]$$

We solve and get

$$S \leq P_A(T_A + T_B) - T_A + C_B - \tfrac{\alpha_B}{1-\alpha_B}\{[(1-P_A)Q_B^W + P_A Q_B^D]R - Q_B^L R\}$$

Hence, the maximum that country B will accept would be

$$S^* = P_A(T_A + T_B) - T_A + C_B - \tfrac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A)Q_B^W + P_A Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

B.4 Analysis for 2.3.3 Autocracy vs. Autocracy

Using the backward induction, in the subgame country A will choose to go to war if the expected payoff of starting a war is bigger than the payoff of giving up: $E_A(Quit) < E_A(War)$.

$$E_A(Quit) = (1-\alpha_A)W_A + \alpha_A R$$

$$E_A(War) = P_A(1-\alpha_A)(W_A - C_A + T_B) + (1-P_A)(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A R$$

We solve and get

$$P_A > \frac{C_A + T_A}{T_A + T_B}$$

And when the above inequality is satisfied, country B will accept A's proposal if $E_B(Accept) \geq E_B(Reject)$.

$$E_B(Accept) = (1-\alpha_B)(W_B - S) + \alpha_B R$$

$$E_B(Reject) = P_A(1-\alpha_B)(W_B - C_B - T_B) + (1-P_A)(1-\alpha_B)(W_B - C_B + T_A) + \alpha_B R$$

We solve and get

$$S \leq P_A(T_A + T_B) - T_A + C_B$$

Hence, the maximum that country B will accept would be

$$S^* = P_A(T_A + T_B) - T_A + C_B$$

B.5 Analysis for 2.4.1a iii. Combine with political regime

Democracy vs. Democracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R\}$$
$$+ (1-\gamma)\{(1-\alpha_B)(W_B + T_A - C_B - P_A^L(T_A+T_B)] + \alpha_B[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = C_B - T_A + \frac{\alpha_B}{1-\alpha_B}(Q_B^L - Q_B^W)R + [\gamma P_A^H + (1-\gamma)P_A^L][T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A+T_B)] + \alpha_A[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A Q_A^L R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq 1 - \frac{C_A + C_B - X - Y}{(P_A^H - P_A^L)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]} \qquad (= DD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

Autocracy vs. Autocracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A + T_B)] + \alpha_B R\}$$

$$+ (1-\gamma)\{(1-\alpha_B)(W_B + T_A - C_B - P_A^L(T_A + T_B)] + \alpha_B R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = C_B - T_A + [\gamma P_A^H + (1-\gamma)P_A^L](T_A + T_B)$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A+T_B)] + \alpha_A R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq 1 - \frac{C_A + C_B}{(P_A^H - P_A^L)(T_A+T_B)} \qquad (=AA)$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

Democracy vs. Autocracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B R\}$$

$$+ (1-\gamma)\{(1-\alpha_B)(W_B + T_A - C_B - P_A^L(T_A+T_B)] + \alpha_B R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = C_B - T_A + [\gamma P_A^H + (1-\gamma)P_A^L](T_A + T_B)$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A + T_B)] + \alpha_A[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A Q_A^L R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq 1 - \frac{C_A + C_B - X}{(P_A^H - P_A^L)(T_A + T_B)} \qquad (= DA)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

Autocracy vs. Democracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R\}$$
$$+ (1-\gamma)\{(1-\alpha_B)(W_B + T_A - C_B - P_A^L(T_A+T_B)] + \alpha_B[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = C_B - T_A + \frac{\alpha_B}{1-\alpha_B}(Q_B^L - Q_B^W)R + [\gamma P_A^H + (1-\gamma)P_A^L][T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A+T_B)] + \alpha_A R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq 1 - \frac{C_A + C_B - Y}{(P_A^H - P_A^L)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]} \qquad (= AD)$$

where

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

B.6 Analysis for 2.4.1b iii. Combine with political regime

Democracy vs. Democracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R\}$$
$$+ (1-\gamma)\{(1-\alpha_B)W_B + \alpha_B Q_B^Q R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = \gamma\{C_B - T_A + \frac{\alpha_B}{1-\alpha_B}(Q_B^Q - Q_B^W)R + P_A^H[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]\}$$
$$+ \frac{\alpha_B}{1-\alpha_B}(Q_B^L - Q_B^Q)R$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A+T_B)] + \alpha_A[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A Q_A^L R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq \frac{P_A^H(T_A+T_B)-T_A-C_A+X+\frac{\alpha_B}{1-\alpha_B}(Q_B^Q-Q_B^L)R}{P_A^H(T_A+T_B)-T_A+C_B-Y} \qquad (=DD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^Q R\}$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

Autocracy vs. Autocracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B R\}$$

$$+ (1-\gamma)\{(1-\alpha_B)W_B + \alpha_B R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = \gamma[C_B - T_A + P_A^H(T_A+T_B)]$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A+T_B)] + \alpha_A R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq \frac{P_A^H(T_A+T_B) - T_A - C_A}{P_A^H(T_A+T_B) - T_A + C_B} \qquad (=AA)$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

Democracy vs. Autocracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B R\}$$
$$+ (1-\gamma)\{(1-\alpha_B)W_B + \alpha_B R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = \gamma[C_B - T_A + P_A^H(T_A + T_B)]$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A + T_B)] + \alpha_A[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A Q_A^L R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq \frac{P_A^H(T_A + T_B) - T_A - C_A + X}{P_A^H(T_A + T_B) - T_A + C_B} \qquad (= DA)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

Autocracy vs. Democracy:

The payoff of playing strategy *Compromise* for country B would be

$$E(Compromise) = (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

The expected payoff of playing strategy *Reject* is

$$E(Reject) = \gamma\{(1-\alpha_B)[W_B + T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R\}$$
$$+ (1-\gamma)\{(1-\alpha_B)W_B + \alpha_B Q_B^Q R\}$$

The maximum amount country A can propose to avoid being rejected is

$$S^* = \gamma\{C_B - T_A + \frac{\alpha_B}{1-\alpha_B}(Q_B^Q - Q_B^W)R + P_A^H[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]\}$$
$$+ \frac{\alpha_B}{1-\alpha_B}(Q_B^L - Q_B^Q)R$$

If country A is High type, its expected payoff from war is

$$E(War) = (1-\alpha_A)[W_A - T_A - C_A + P_A^H(T_A+T_B)] + \alpha_A R$$

The expected payoff from war proposing S^*

$$E(S^*) = (1-\alpha_A)(W_A + S^*) + \alpha_A R$$

If $E(War) \geq E(S^*)$, it will prefer B to reject its proposal and then goes to war. We get

$$\gamma \leq \frac{P_A^H(T_A+T_B) - T_A - C_A + \frac{\alpha_B}{1-\alpha_B}(Q_B^Q - Q_B^L)R}{P_A^H(T_A+T_B) - T_A + C_B - Y} \qquad (= AD)$$

where

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^Q R\}$$

If country A is Low type, we can prove getting involved into war is never better than proposing exactly S^* and country B will accept it.

B.7 Analysis for 2.4.2a iii. Combine with political regime

Not updated **Democracy vs. Democracy:**

Definition of Strategies for Country A

• Strategy $S^L = P_A^L(T_A+T_B) - T_A + C_B - \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R - Q_B^L R\}$ (This is the the maximum amount that low-type country B will accept)

• Strategy $S^H = P_A^H(T_A+T_B) - T_A + C_B - \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R - Q_B^L R\}$ (This is the the maximum amount that high-type country B will accept)

Then the expected payoff of playing strategy S^H for country A would be

$$E_A(S^H) = (1-\alpha_A)(W_A + S^H) + \alpha_A Q_A^L R$$

and the expected payoff of playing stategy S^L is

$$E_A(S^L) = \gamma\{P_A^H[(1-\alpha_A)(W_A - C_A + T_B) + \alpha_A Q_A^W R] + (1-P_A^H)[(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A Q_A^D R]\} + (1-\gamma)[(1-\alpha_A)(W_A + S^L) + \alpha_A Q_A^L R]$$

When $E(S^H) \leq E(S^L)$, which means when

$$\gamma \leq \frac{(P_A^L - P_A^H)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]}{C_A + C_B + (P_A^L - P_A^H)(T_A+T_B) - X - Y} \qquad (= DD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

Autocracy vs. Autocracy:

Definition of Strategies for Country A

• Strategy $S^L = P_A^L(T_A+T_B) - T_A + C_B$ (This is the the maximum amount that low-type country B will accept)

• Strategy $S^H = P_A^H(T_A+T_B) - T_A + C_B$ (This is the the maximum amount that high-type country B will accept)

Then the expected payoff of playing strategy S^H for country A would be

$$E_A(S^H) = (1-\alpha_A)(W_A + S^H) + \alpha_A R$$

and the expected payoff of playing stategy S^L is

$$E_A(S^L) = \gamma\{P_A^H[(1-\alpha_A)(W_A - C_A + T_B) + \alpha_A R] + (1-P_A^H)[(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A R]\} + (1-\gamma)[(1-\alpha_A)(W_A + S^L) + \alpha_A R]$$

When $E(S^H) \leq E(S^L)$, which means when

$$\gamma \leq \frac{(P_A^L - P_A^H)(T_A+T_B)}{C_A + C_B + (P_A^L - P_A^H)(T_A+T_B)} \qquad (=AA)$$

Democracy vs. Autocracy:

Definition of Strategies for Country A

• Strategy $S^L = P_A^L(T_A + T_B) - T_A + C_B$ (This is the the maximum amount that low-type country B will accept)

• Strategy $S^H = P_A^H(T_A + T_B) - T_A + C_B$ (This is the the maximum amount that high-type country B will accept)

Then the expected payoff of playing strategy S^H for country A would be

$$E_A(S^H) = (1-\alpha_A)(W_A + S^H) + \alpha_A Q_A^L R$$

and the expected payoff of playing stategy S^L is

$$_AE(S^L) = \gamma\{P_A^H[(1-\alpha_A)(W_A - C_A + T_B) + \alpha_A Q_A^W R] + (1-P_A^H)[(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A Q_A^D R]\} + (1-\gamma)[(1-\alpha_A)(W_A + S^L) + \alpha_A Q_A^L R]$$

When $E(S^H) \leq E(S^L)$, which means when

$$\gamma \leq \frac{(P_A^L - P_A^H)(T_A + T_B)}{C_A + C_B + (P_A^L - P_A^H)(T_A + T_B) - X} \qquad (= DA)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^H Q_A^W + (1-P_A^H)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

Autocracy vs. Democracy:

Definition of Strategies for Country A

• Strategy $S^L = P_A^L(T_A+T_B) - T_A + C_B - \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R - Q_B^L R\}$ (This is the the maximum amount that low-type country B will accept)

• Strategy $S^H = P_A^H(T_A+T_B) - T_A + C_B - \frac{\alpha_B}{1-\alpha_B}\{[(1-P_A^H)Q_B^W + P_A^H Q_B^D]R - Q_B^L R\}$ (This is the the maximum amount that high-type country B will accept)

Then the expected payoff of playing strategy S^H for country A would be

$$E_A(S^H) = (1-\alpha_A)(W_A + S^H) + \alpha_A R$$

and the expected payoff of playing stategy S^L is

$$E_A(S^L) = \gamma\{P_A^H[(1-\alpha_A)(W_A - C_A + T_B) + \alpha_A R] + (1-P_A^H)[(1-\alpha_A)(W_A - C_A - T_A) + \alpha_A R]\} + (1-\gamma)[(1-\alpha_A)(W_A + S^L) + \alpha_A R]$$

When $E(S^H) \leq E(S^L)$, which means when

$$\gamma \leq \frac{(P_A^L - P_A^H)[T_A + T_B + \frac{\alpha_B}{1-\alpha_B}(Q_B^W - Q_B^D)R]}{C_A + C_B + (P_A^L - P_A^H)(T_A+T_B) - Y} \qquad (= AD)$$

where

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^L R\}$$

B.8 Analysis for 2.4.2b iii. Combine with political regime

Democracy vs. Democracy:

i. Actions of Country B

$$E_B^H(C^H,C^L) = E_B^L(C^H,C^L) = E_B^H(C^H,R^L) = E_B^L(R^H,C^L)$$

$$= (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

$$E_B^H(R^H,C^L) = (1-\alpha_B)W_B + \alpha_B Q_B^Q R$$

$$E_B^H(R^H,R^L) = \gamma[(1-\alpha_B)W_B + \alpha_B Q_B^Q R]$$

$$+ (1-\gamma)\{(1-\alpha_B)[W_B - C_B + T_A - P_A^H(T_A+T_B)] + \alpha_B[P_A^H Q_B^D + (1-P_A^H)Q_B^W]R\}$$

$$= (1-\alpha_B)\{W_B + (1-\gamma)[T_A - C_B - P_A^H(T_A+T_B)]\}$$

$$+ \alpha_B\{\gamma Q_B^Q + (1-\gamma)[P_A^H Q_B^D + (1-P_A^H)Q_B^W]\}R$$

$$E_B^L(R^H,R^L) = (1-\alpha_B)\{W_B + (1-\gamma)[T_A - C_B - P_A^L(T_A+T_B)]\}$$

$$+ \alpha_B\{\gamma Q_B^Q + (1-\gamma)[P_A^L Q_B^D + (1-P_A^L)Q_B^W]\}R$$

$$E_B^L(C^H,R^L) = (1-\alpha_B)[W_B - C_B + T_A - P_A^L(T_A+T_B)] + \alpha_B[P_A^L Q_B^D + (1-P_A^L)Q_B^W]R$$

and

$$E_B^H(R^H,C^L) > E_B^H(R^H,R^L) > E_B^L(R^H,R^L) > E_B^L(C^H,R^L)$$

ii. Actions of Country A

(1) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) \geq E_B^L(R^H,R^L)$, i.e.

$$S \leq (1-\gamma)[C_B - T_A + P_A^L(T_A+T_B)] + (1-\gamma)\frac{\alpha_B}{1-\alpha_B}\{Q_B^Q - [P_A^L Q_B^D + (1-P_A^L)Q_B^W]\}R$$
$$+ \frac{\alpha_B}{1-\alpha_B}(Q_B^L - Q_B^Q) = S^*$$

Country B plays (R^H,C^L).

(2) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) < E_B^L(R^H,R^L)$, i.e.

$$S > S^*$$

Country B plays (R^H,R^L).

The expected payoff of country A will be

$$E_A(S^*) = \gamma[(1-\alpha_A)W_A + \alpha_A Q_A^Q R] + (1-\gamma)[(1-\alpha_A)(W_A+S^*) + \alpha_A Q_A^L R]$$

$$E_A(>S^*) = \gamma[(1-\alpha_A)W_A + \alpha_A Q_A^Q R]$$
$$+ (1-\gamma)\{(1-\alpha_A)[W_A - C_A - T_A + P_A^L(T_A+T_B)] + \alpha_A[P_A^L Q_A^W + (1-P_A^L)Q_A^D]R\}$$

War only happens if country A proposes more than S^*. Country A would like to propose more than S^* if

$$E_A(> S^*) \geq E_A(S^*)$$

We solve and get

$$1-\gamma \leq 1 - \frac{P_A^L(T_A+T_B) - T_A - C_A + X}{P_A^L(T_A+T_B) - T_A + C_B - Y} \qquad (= DD)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^L Q_A^W + (1-P_A^L)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^Q R\}$$

Autocracy vs. Autocracy:

i. Actions of Country B

$$E_B^H(C^H, C^L) = E_B^L(C^H, C^L) = E_B^H(C^H, R^L) = E_B^L(R^H, C^L)$$

$$= (1-\alpha_B)(W_B - S) + \alpha_B R$$

$$E_B^H(R^H, C^L) = (1-\alpha_B)W_B + \alpha_B R$$

$$E_B^H(R^H, R^L) = (1-\alpha_B)W_B + (1-\gamma)(1-\alpha_B)[T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B R$$

$$E_B^L(R^H,R^L) = (1-\alpha_B)W_B + (1-\gamma)(1-\alpha_B)[T_A - C_B - P_A^L(T_A+T_B)] + \alpha_B R$$

$$E_B^L(C^H,R^L) = (1-\alpha_B)[W_B - C_B + T_A - P_A^L(T_A+T_B)] + \alpha_B R$$

and

$$E_B^H(R^H,C^L) > E_B^H(R^H,R^L) > E_B^L(R^H,R^L) > E_B^L(C^H,R^L)$$

ii. Actions of Country A

(1) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) \geq E_B^L(R^H,R^L)$, i.e.

$$S \leq (1-\gamma)[C_B - T_A + P_A^L(T_A+T_B)] = S^*$$

Country B plays (R^H,C^L).

(2) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) < E_B^L(R^H,R^L)$, i.e.

$$S > S^*$$

Country B plays (R^H,R^L).

The expected payoff of country A will be

$$E_A(S^*) = \gamma[(1-\alpha_A)W_A + \alpha_A R] + (1-\gamma)[(1-\alpha_A)(W_A+S^*) + \alpha_A R]$$

$$E_A(>S^*) = (1-\alpha_A)W_A + (1-\gamma)\{(1-\alpha_A)[P_A^L(T_A+T_B) - C_A - T_A]\} + \alpha_A R$$

War only happens if country A proposes more than S^*. Country A would like to propose more than S^* if

$$E_A(>S^*) \geq E_A(S^*)$$

We solve and get

$$1-\gamma \leq \frac{P_A^L(T_A+T_B) - T_A - C_A}{P_A^L(T_A+T_B) - T_A + C_B} \qquad (=AA)$$

Democracy vs. Autocracy:

i. Actions of Country B

$$E_B^H(C^H,C^L) = E_B^L(C^H,C^L) = E_B^H(C^H,R^L) = E_B^L(R^H,C^L)$$

$$= (1-\alpha_B)(W_B - S) + \alpha_B R$$

$$E_B^H(R^H,C^L) = (1-\alpha_B)W_B + \alpha_B R$$

$$E_B^H(R^H,R^L) = (1-\alpha_B)W_B + (1-\gamma)(1-\alpha_B)[T_A - C_B - P_A^H(T_A+T_B)] + \alpha_B R$$

$$E_B^L(R^H,R^L) = (1-\alpha_B)W_B + (1-\gamma)(1-\alpha_B)[T_A - C_B - P_A^L(T_A+T_B)] + \alpha_B R$$

$$E_B^L(C^H,R^L) = (1-\alpha_B)[W_B - C_B + T_A - P_A^L(T_A+T_B)] + \alpha_B R$$

and

$$E_B^H(R^H,C^L) > E_B^H(R^H,R^L) > E_B^L(R^H,R^L) > E_B^L(C^H,R^L)$$

ii. Actions of Country A

(1) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) \geq E_B^L(R^H,R^L)$, i.e.

$$S \leq (1-\gamma)[C_B - T_A + P_A^L(T_A+T_B)] = S^*$$

Country B plays (R^H,C^L).

(2) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) < E_B^L(R^H,R^L)$, i.e.

$$S > S^*$$

Country B plays (R^H,R^L).

The expected payoff of country A will be

$$E_A(S^*) = \gamma[(1-\alpha_A)W_A + \alpha_A Q_A^Q R] + (1-\gamma)[(1-\alpha_A)(W_A+S^*) + \alpha_A Q_A^L R]$$

$$E_A(>S^*) = \gamma[(1-\alpha_A)W_A + \alpha_A Q_A^Q R]$$

$$+(1-\gamma)\{(1-\alpha_A)[W_A - C_A - T_A + P_A^L(T_A+T_B)] + \alpha_A[P_A^L Q_A^W + (1-P_A^L)Q_A^D]R\}$$

War only happens if country A proposes more than S^*. Country A would like to propose more than S^* if

$$E_A(>S^*) \geq E_A(S^*)$$

We solve and get

$$1-\gamma \leq \frac{P_A^L(T_A+T_B) - T_A - C_A + X}{P_A^L(T_A+T_B) - T_A + C_B} \qquad (=DA)$$

where

$$X = \frac{\alpha_A}{1-\alpha_A}\{\overbrace{[P_A^L Q_A^W + (1-P_A^L)Q_A^D]R}^{\text{Expected Rent from War}} - Q_A^L R\}$$

Autocracy vs. Democracy:

i. Actions of Country B

$$E_B^H(C^H,C^L) = E_B^L(C^H,C^L) = E_B^H(C^H,R^L) = E_B^L(R^H,C^L)$$

$$= (1-\alpha_B)(W_B - S) + \alpha_B Q_B^L R$$

$$E_B^H(R^H,C^L) = (1-\alpha_B)W_B + \alpha_B Q_B^Q R$$

$$E_B^H(R^H,R^L) = \gamma[(1-\alpha_B)W_B + \alpha_B Q_B^Q R]$$

$$+ (1-\gamma)\{(1-\alpha_B)[W_B - C_B + T_A - P_A^H(T_A+T_B)] + \alpha_B[P_A^H Q_B^D + (1-P_A^H)Q_B^W]R\}$$

$$= (1-\alpha_B)\{W_B + (1-\gamma)[T_A - C_B - P_A^H(T_A+T_B)]\}$$

$$+ \alpha_B\{\gamma Q_B^Q + (1-\gamma)[P_A^H Q_B^D + (1-P_A^H)Q_B^W]\}R$$

$$E_B^L(R^H,R^L) = (1-\alpha_B)\{W_B + (1-\gamma)[T_A - C_B - P_A^L(T_A+T_B)]\}$$

$$+ \alpha_B\{\gamma Q_B^Q + (1-\gamma)[P_A^L Q_B^D + (1-P_A^L)Q_B^W]\}R$$

$$E_B^L(C^H,R^L) = (1-\alpha_B)[W_B - C_B + T_A - P_A^L(T_A+T_B)] + \alpha_B[P_A^L Q_B^D + (1-P_A^L)Q_B^W]R$$

and

$$E_B^H(R^H,C^L) > E_B^H(R^H,R^L) > E_B^L(R^H,R^L) > E_B^L(C^H,R^L)$$

ii. Actions of Country A

(1) Suppose $E_B^L(C^H,C^L) = E_B^L(R^H,C^L) \geq E_B^L(R^H,R^L)$, i.e.

$$S \leq (1-\gamma)[C_B - T_A + P_A^L(T_A+T_B)] + (1-\gamma)\frac{\alpha_B}{1-\alpha_B}\{Q_B^Q - [P_A^L Q_B^D + (1-P_A^L)Q_B^W]\}R$$

$$+ \frac{\alpha_B}{1-\alpha_B}(Q_B^L - Q_B^Q) = S^*$$

Country B plays (R^H,C^L).

(2) Suppose $E_B^L(C^H, C^L) = E_B^L(R^H, C^L) < E_B^L(R^H, R^L)$, i.e.

$$S > S^*$$

Country B plays (R^H, R^L).

The expected payoff of country A will be

$$E_A(S^*) = \gamma[(1-\alpha_A)W_A + \alpha_A R] + (1-\gamma)[(1-\alpha_A)(W_A + S^*) + \alpha_A R]$$

$$E_A(> S^*) = (1-\alpha_A)W_A + (1-\gamma)\{(1-\alpha_A)[P_A^L(T_A+T_B) - C_A - T_A]\} + \alpha_A R$$

War only happens if country A proposes more than S^*. Country A would like to propose more than S^* if

$$E_A(> S^*) \geq E_A(S^*)$$

We solve and get

$$1-\gamma \leq \frac{P_A^L(T_A+T_B) - T_A - C_A}{P_A^L(T_A+T_B) - T_A + C_B - Y} \qquad (= AD)$$

where

$$Y = \frac{\alpha_B}{1-\alpha_B}\{\underbrace{[(1-P_A^L)Q_B^W + P_A^L Q_B^D]R}_{\text{Expected Rent from War}} - Q_B^Q R\}$$

Appendix C

C.1 Analysis for 3.4.1 Fighting within Coalition

The first order conditions for equations (3.3)-(3.5): $\frac{\partial U_G}{\partial M_G} = 0$, $\frac{\partial U_1}{\partial M_1} = 0$, and $\frac{\partial U_2}{\partial M_2} = 0$

$$\frac{\partial U_G}{\partial M_G} = -1 + \sum \frac{M_i T_i}{(M_i + M_G)^2} = 0 \qquad \text{i=1,2}$$

$$\frac{\partial U_1}{\partial M_1} = -1 + \frac{M_G T_1}{(M_1 + M_G)^2} = 0$$

$$\frac{\partial U_2}{\partial M_2} = -1 + \frac{M_G T_2}{(M_2 + M_G)^2} = 0$$

Solve and we get

$$M_G^* = M_1^* + M_2^*$$

$$M_1^* = \frac{1}{9}(\sqrt{T_1 T_2} + 2T_1 - T_2)$$

$$M_2^* = \frac{1}{9}(\sqrt{T_1 T_2} + 2T_2 - T_1)$$

Thus, the payoffs of two rebel groups without coalition would be

$$U_1 = R_1 - M_1^* - (1 - \frac{M_1^*}{M_1^* + M_G^*})T_1 - C_1$$

$$U_2 = R_2 - M_2^* - (1 - \frac{M_2^*}{M_2^* + M_G^*})T_2 - C_2$$

The payoffs of two rebel group if they form a coalition would be

$$V_1 = \frac{M_1^*}{M_1^* + M_2^*} U_{12}$$

$$V_2 = \frac{M_2^*}{M_1^* + M_2^*} U_{12}$$

where

$$U_{12} = R_1 + R_2 - (M_1^* + M_2^*) - (1 - \frac{M_1^* + M_2^*}{M_1^* + M_2^* + M_G^*})(T_1 + T_2) - (C_1 + C_2)$$

Substitute them into conditions (3.8), and we have the conditions for the rebel groups to form a coalition:

$$[R_1 - C_1 + 2(R_2 - C_2) - \frac{2}{3}T_1 - \frac{2}{3}T_2]\sqrt{T_1} + \frac{7}{6}T_1\sqrt{T_2} \geq [R_2 - C_2 + 2(R_1 - C_1) - \frac{1}{2}T_2]\sqrt{T_2} \tag{C.1}$$

$$[R_1 - C_1 + 2(R_2 - C_2) - \frac{1}{2}T_1 - \frac{7}{6}T_2]\sqrt{T_1} + \frac{2}{3}T_1\sqrt{T_2} \leq [R_2 - C_2 + 2(R_1 - C_1) - \frac{2}{3}T_2]\sqrt{T_2} \tag{C.2}$$

As the tax is assumed to be much less than the available resource, the contents in all square brackets are positive. Hence, we can prove that the first-order derivative of left hand sides

of both conditions increase with T_1, which make condition (C.1) more likely to be satisfied and condition (C.2) less likely to be satisfied.

The increase of T_2 has the opposite effect if we rearrange (C.1) and (C.2) to put all T_2 related terms on one side.