The Economics of Military Spending, Conflict and Growth

Nan Tian

A Thesis submitted to the University of Cape Town
in fulfilment of the requirements for the degree of

Doctor of Philosophy
in
Economics

School of Economics
University of Cape Town

November 29, 2015

Dedicated to the loving memories of my mother.
I love and miss you.

Acknowledgements

First and foremost, I want to thank my supervisor Professor John Paul Dunne for his guidance, support, encouragement and insight towards my thesis. Since my Masters, Paul has inspired many of my research ideas and provided me with invaluable opportunities to present my work at international conferences. I appreciate all his contributions of time, ideas and funding to make my Ph.D experience productive and enjoyable. His passion for research and expertise as a professor is matched by no other, and I am thankful for everything he has passed down to me.

I would also like to acknowledge the financial aid received from the DAAD-NRF, UCT research scholarship and Carnegie, without which my Ph.D would have been impossible.

Many thanks go to Olaf de Groot for his help with datasets and Ron Smith for discussions and comments. I greatly appreciate all the feedback provided by participants of the CSAE conferences, the Jan Tinbergen European Peace Science conferences and the Annual International Conference on Economics and Security.

I am also deeply grateful to Odelia Beryl Lutchman who stood by my side throughout my Ph.D journey, providing a great deal of support, encouragement, prayers and friendship.

Lastly, I would like to thank my parents, Qing and Lucheng Tian, for all their love, encouragement and unconditional support in all my pursuits. Thank you.

Abstract

This dissertation is a collection of studies on the economics of peace and security. Chapter one introduces the roles military spending and conflict play in affecting economic growth, while also considering the causes of civil conflict.

Chapter two investigates the relationship between military expenditure and economic growth, considering group heterogeneity and non-linearity. Using an exogenous growth model and dynamic panel approach, the results suggest military burden to have a negative effect on growth. Breaking the overall panel down into various sub-samples shows estimates that are remarkably consistent with the full panel. These results provide strong support for the argument that military spending has an adverse effect on growth. There are, however, some intriguing results suggesting that for certain types of countries military burden has no negative growth effect.

Chapter three deals with the transnational spatial spillover effects of conflict on neighbouring countries. It moves beyond using geographical distance as a spillover measurement and allows for economic and political distances. The initial empirical results suggest that conflict has a strong negative spillover effect on directly contiguous countries growth, but no significant impacts were observed for non-contiguous countries. When economic and political factors are considered, this result remains, but the spillover effect is smaller. While the impact of conflict remains devastating, it is important to take other factors into account as studies using only geographical distance may be overestimating the impact on neighbours.

The fourth chapter examines the determinants of civil war, using a zero-inflated modelling approach to deal with excess zeroes in the dependent variable. Traditional probit and logit models have limited capacity in dealing with this issue and can create misleading results, which is illustrated through

replicating published work. A general greed-grievance model is then estimated giving further support to using zero-inflated models. While the standard probit models tend to emphasise opportunity variables, consistent in other studies, the zero-inflated model gives supports both opportunity and grievance variables. In particular, ethnicity, democracy and inequality are found to play a significant role in civil war prevalence.

Finally, chapter five summarises the findings of the dissertation, providing some policy recommendations, concluding remarks and discusses future research opportunities.

Contents

List of Figures

List of Tables

CHAPTER 1

An Introduction To Military Spending, Conflict and Economic Growth

1.1 Introduction

Economics of peace and security is a sub-field of economics that seeks to understand the causes and effects of violent conflict and military spending. In each case, the primary concerns is finding ways each can be avoided, managed or in the case of conflict, resolved. These aspects are often thought to be intertwined, leading to clear and significant relationships between military spending, conflict and economic growth. For instance, almost every single country in the world spends on the military, with spending ranging from an astonishing 35% of GDP to as low as 0%. While the developed nations often can afford to allocate a proportion of their government budget to military expenditure, most non-developed countries have astonishing levels of poverty and governments that continue to devote a substantial portion of

their resources to military spending. Military spending in these developing countries is often unaffordable and unsustainable, which leads to important developmental concerns. One that as early as Benoit (1973) who found a positive correlation between development and military spending and started a vigorous debate that continues to this day.

A similar comparison can be drawn on the link between conflict and economic development, with the causality thought to flow from conflict to development (Rodrik, 1999). The cost of conflict is considerable. During a war, the growth rate of a country is typically reduced by 2.2% (Collier, 1999). These losses can continue post-war, with Cerra and Saxena (2008) finding output to decline by about 6% after a civil war. From a macroeconomic view point, conflict is generally harmful to economic growth and this is almost always the result of devastating effects on life, health and infrastructure, which leads to poverty and decreased living standards. This harmful effect not only affects the host nation, but neighbouring countries as well, with its spillover effects numerous and non-trivial (Murdoch and Sandler, 2002a).

Since both military spending and conflict can affect economic growth, an overlap between these respective literatures is the causes of conflict. With conflict potentially having such devastating effects, an important research question is what causes conflict. Considerable empirical research has been generated by the "greed-grievance" debate which was started by Collier and Hoeffler (1998) and Keen (1998). Together with Collier and Hoeffler (2004) and Fearon and Laitin (2003), the authors argued that theoretically conflict can be caused by long standing differences in ethnicity and religion, lack of democracy, economic inequalities or poverty. Yet, from a statistical perspective the only explanation is that of poverty or lack of development. When economic, political and social characteristics have been considered, countries that are poorer, slower growing and subject to adverse income shocks are substantially more at risk to civil conflict (Blattman and Miguel, 2010). In other words, it is variables relating to greed or opportunity that explain civil war risk and not those of objective grievance. Even though there is a general consensus on the correlates of civil war following these initial contributions,

the debate on the appropriate estimators used, measurement of the variables and the true underlying causes of civil conflict remain (Blattman and Miguel, 2010).

Given that both violent conflict and military expenditure both retard growth or development and that low development causes civil conflict, the importance and relevance of academic research surrounding the interactions of military expenditure, conflict and growth is clear and justifiable. This thesis has three broad objectives, which are covered in the next three chapters. These are to investigate the economic effects of military spending with specific focus on group heterogeneity and non-linearity, the costs of armed conflict and its transnational link on neighbouring nations, and the role economic, political and social variables play in determining civil war risk when more appropriate rare events estimators are used. In this way this thesis makes useful contributions to understanding the vicious cycle of underdevelopment, conflict and military spending that too many countries fall into.

1.2 Guns vs. Butter

A major research endeavour in economics has been trying to understand the forces that determine economic growth and factors which cause different countries to grow at different rates and achieve different levels of wealth. Research has shown a broad range of factors that affect sustained economic growth, these vary from the general notion of conditional convergence, investment, trade and institutions, to the rather less familiar impact of military expenditure and conflict (Barro, 1991; Acemoglu et al., 2005; Dollar and Kraay, 2004; Collier, 1999; Dunne et al., 2005).[1]

Military spending is an important topic for the international community. It has influences beyond the resources it takes up, especially when it facilitates conflict. Although military spending temporarily decreased following

[1]Exogenous and endogenous growth theory have found growth rates to be enhanced by higher initial schooling and life expectancy, lower inflation and access to technology.

the end of the Cold War, increases have been seen since the late 1990's, rising to over $1.7 trillion per year. This is equivalent to about 2.3% of global gross domestic product (GDP)(SIPRI, 2014).[2] Moreover, in spite of the ongoing global economic crisis, this trend of high defence spending is continuing and demonstrates that often principles of security are seen as more important than considerations of economic conditions. The literature on the economic effects of military expenditure remains strongly contested, with arguments mainly over its true effects.

The controversy in the literature over military spending's effect on development are divided among three groups. Those against military expenditure argue that even though most countries need some form of security to deal with internal and external threats, any resources used carry an opportunity cost as this redirects resources away from activities that may directly improve economic growth and the pace of development (Knight et al., 1996). On the other hand, military spending may help boost growth if it can provide security, jobs, infrastructure, training and research and development (R&D) (Benoit, 1978; Aizenman and Glick, 2006). These differences in opinions over whether military expenditure has a positive or negative effect on economic growth has led some authors such as Alexander (1990), Ram (1995) and Alptekin and Levine (2012) to point towards the use of different datasets time-periods and empirical models as the main reasons behind the different findings. The issue is then clearly not theoretical, but an empirical question and one that remains an area of considerable debate. In fact, it is very difficult to find any robust empirical relationship between defence and growth (Dunne, 1996; Smith, 2000).

Although past research has not been able to provide a consensus on the economic effects of military spending, more recent cross country studies, using mostly post Cold War data do seem to be providing more consistent support for a negative relationship between defence and growth (Dunne

[2]The only reliable data is the aggregate military expenditure and not any of its components and in any empirical analysis often one can do no more than simply recognise that armed transfers are an important part of military expenditure.

and Tian, 2013). There remain concerns over group heterogeneity and non-linearity as studies of a cross sectional nature often hide more complex patterns. For example, in most developing countries, heterogeneity exists regarding the level of insecurities, stages and nature of development, amounts of trade, natural resource abundance and official development aid received. These differences may account for the substantial amounts of variation in past empirical estimations. Smaldone (2006) suggests that differences in military expenditure's effect on growth may reflect a country's conflict experience, while Yakovlev (2007) argues results may differ depending on arms trade and Looney and McNab (2008) found economic freedom and governance to influence military spending's burden on growth. These mixed results in the literature have pushed researchers to argue that there also exists a non-linear relation between military expenditure and growth. The authors postulate that the effect military spending has on growth is dependent on the level spent and the level of a countries income (Stroup and Sharp, 2001; Dunne, 2012). Low levels of military spending may increase growth and high levels reduce growth, while poorer countries are less able to afford military spending than richer ones.

Motivated by a need to further investigate the above-mentioned claims, chapter two provides an assessment of the importance of group heterogeneity and non-linearity. This includes evaluating the role different country characteristics have on the military spending growth relation. By emphasising the importance of controlling for country specific factors, this study helps distinguish between countries that experience the harmful effects of defence spending to those that do not. In doing so, it also offers explanations to why certain characteristics matter and through which channels these variables affect the military spending growth relation. Thus, one can see this study as providing a robustness check on the defense-growth nexus.

Following Dunne et al.'s (2005) theoretical model, military expenditure is estimated on economic growth through an augmented Solow model. The growth equation can be specified to include the usual growth variables and military spending as a percentage of GDP. Using a dynamic panel estimation

technique on 106 countries over a 21-year period, this chapter finds defence spending to have an adverse effect on economic growth. It adds to the growing consensus that in the post-Cold War era, defence spending is harmful to development.

1.3 Spillover Effects of Conflict

Violent conflict has always been a relatively common phenomenon, but one that has recently changed from predominantly interstate conflicts to more intrastate conflicts (Collier et al., 2003). These wars are also persistent, their duration has steadily increased over the past half century (Fearon, 2004). Understanding the causes and consequences of violent conflict is therefore of vital importance. Blattman and Miguel (2010) correctly pointed out that development economists have often overlooked conflict and many economic courses and textbooks do not have conflict as part of their syllabi. Recently though, more and more economists have started to work to better understand its causes and legacies.

The economic legacies of violent conflict are generally considered to devastate economic development and the effects are wide ranging not only for the countries directly affected, but also for neighbours. These harmful costs are both economic and social, with effects in the short, medium and long-term (Blattman and Miguel, 2010). Short and medium term costs generally arise during conflict with immediate impacts on factors of production (physical capital, labour or human capital), technology, institutions and culture. Longer-term or legacy costs are often only visible after a conflict and are commonly in the social, institutional and environmental form (Dunne, 2013). Most scholars agree that short and medium run impact of conflict is clearly disastrous. There is, however, mixed evidence on its long-run costs with differing opinions. These range from substantial social, institutional and psychological legacy costs of conflict as suggested by Collier et al. (2003) to few visible economic legacies as argued by Miguel and Roland (2006) to

conflict having potentially a modernising effect in the long-term process of economic development (Ruttan, 2006).

Most costs resulting from conflict can be considered to have a disproportionate effect on poorer countries. As historical evidence suggest, poorest countries in urgent need of economic development are often the ones embroiled in violent fighting with devastating effects (Blattman and Miguel, 2010). These wars range from mild skirmishes in countries such as Burkina Faso to large scale massacres in Rwanda, Democratic Republic of Congo (DRC) and Sudan. In Rwanda, for example, over 20% of the population moved into poverty following the genocide (Justino and Verwimp, 2006). An even worse case was seen in the DRC, where during the Second Congo War, an estimated 3.9 million people had died, with most attributed to poor healthcare, malnutrition and deterioration of infrastructure (Coghlan et al., 2007). Some have argued that these disproportionate and destructive effects may be so great that it could account for the income gap between the world's richest and poorest countries (Collier et al., 2003). This led to an important developmental concern and in order to help these countries recover (e.g. humanitarian aid) one must be able to ascertain the full consequences of the conflict.

While the empirical literature on the costs of conflict has been growing, the spillover effects of conflict have greatly been neglected. These contagion effects resulting from conflict are both important and considerable (Black, 2013; Bosker and Ree, 2014). Refugee flows, disease, illicit trade of banned goods and conflict itself can spillover into neighbouring countries, substantially hampering economic growth in those countries as well as the region (Murdoch and Sandler, 2004; de Groot, 2010). This recent move to assess the conflict spillover is important, but it has been limited to using only geography as a distance measurement. Instead, spatial econometric studies should consider other factors of distance such as political and economic similarities (Beck et al., 2006).

Chapter three adds to the debate in the literature by investigating the transnational spillover effects of conflict on economic growth for Africa, con-

sidering an integrated distance measure that includes geographic, economic and political factors. A dynamic panel analysis of the spillover effects of conflict in Africa is undertaken using a contiguity matrix that reflects distance in geographic, economic and political terms. Annual data is used instead of the popular five year averages, with results providing useful and valuable contributions to the growing conflict spillover literature. Spillover effects resulting from conflict are likely to be different for countries with different amounts of economic integration, political similarity and geographic distance, therefore using a more comprehensive spillover measure could help to more accurately measure the spillover effects of conflict. The estimation results with the contiguity matrix reflecting geographic, political and economic similarities supports the notion that violent conflict in a host nation leads to substantial multi-dimensional spillover effects onto neighbouring countries.

1.4 Determinants of Civil War

Just as measuring the costs of conflict is an important developmental concern, understanding the factors that make conflict, in particular civil war, more or less likely to occur is also of great importance. It helps policy makers and scholars formulate responses to decrease future civil war risk and set a foundation for persistent economic growth. Violent internal conflict has ravaged many states in the world. According to the UCDP/PRIO data set, counting all countries and years since 1960, the average annual prevalence of civil war is about 12%, with a peak of over 17% in the years 1990 and 1991. The cumulative battle related deaths in worldwide civil conflicts between 1960 and 2013 is close to 8 million, with total war deaths around 18 million (Lacina and Gleditsch, 2005; Themner and Wallensteen, 2014). To understand the forces behind this source of human misery, research on why civil war occurs have thus become a major focus, creating a vast body of quantitative and qualitative literature that analyses issues such as civil war onset, incidence, duration, termination and severity (Cunningham and Lemke, 2014).

Focusing on the causes of civil conflict, the literature has been dominated by cross-country regressions, with the correlates of war reasonably well established. Civil conflict, an increasingly common phenomenon, can be explained through the general concepts of motivation and feasibility. This is a distinction made obvious by Collier and Hoeffler's (2004) contribution on whether greed or grievance explains civil conflict onset. Rebellion can be motivated by a need to redress objective grievances or by opportunities that generate private gain (e.g. greed). However, participation by rebels can also be due to feasibility of collective co-ordination or conflict success. Civil wars are considered more likely to occur in countries that are poor, are subject to income shocks, have weak institutions, have sparsely populated regions outside city centres that possess mountainous or forest terrain (Blattman and Miguel, 2010). This is an assertion that has mostly been empirically backed up in the literature. Early studies by Fearon and Laitin (2003) and Collier and Hoeffler (2004) suggest economic incentives are decisive in predicting civil wars, while political grievances have little explanatory power. These authors link their findings to weak state capacity and low opportunity cost facing rebels as the main explanations to engendering war.

From these seminal contributions, the literature on the causes of civil conflict has branched into numerous avenues with recent research focusing on improving causal identification and measurement. Although there is a general consensus linking civil conflict to low levels of income and negative income shocks, the direction of the causation remains contested. To address this endogeneity concern, scholars have looked to isolate the exogenous variation in income, choosing rainfall as an instrument for income growth (Miguel et al., 2004). To illustrate the importance of better measurement, Ross (2006) argue that compared to older natural resource measures, improved measures of oil and diamond deposits are strongly associated with more civil conflict. Likewise, the lack of significance of the objective grievance variables has been strongly contest in political science. Most recently by Buhaug et al. (2014), who suggests that the lack of significance in the grievance variables may be due to poorly measured proxy variables (e.g. Gini coefficient and

ethno-linguistic fractionalisation) used in previous research. They find that by using variables which better reflect ethnic and income inequality, political and economic grievances do matter.

While there are advancements in the civil war literature to deal with issues such as endogeneity and measurement, some core empirical questions remain. There is currently little agreement on the correct econometric specification in estimating civil war prevalence (Blattman and Miguel, 2010). Authors also vary in the use of annual versus five-year averages, the definition of civil conflict, the appropriate estimator for these rare events, the degree of measurement error in the dependent and independent variables and the concern of an excess number of zero observations in the dependent variable. In light of this, chapter four looks to revisit the civil war literature of greed versus grievance, viewing and addressing issues on the excess zeroes in the dependent variable, the definition of civil conflict, its appropriate estimators and potential measurement errors.

The chapter first addresses the definition of conflict in the literature. Cross-country studies commonly use a zero-one indicator variable to denote conflict and peace and in most cases this dependent variable contains a large number of zero observations (e.g. peace observations). These zeroes have the potential to be heterogeneous and come from different data generating processes. In the case where zeroes are heterogeneous, estimates which use the popular probit or logit models to determine civil war risk can lead to model misspecification and biased estimates (Bagozzi et al., 2015). Additionally, whether the probit and logit models conform to the process that generated the civil conflict data have been questioned, with some authors favouring Poisson models since it is like to better fit the data (Richardson, 1960; Smith and Tasiran, 2012).

To investigate the concerns of excess zeroes and which models best fit the data, this chapter contributes to the literature by suggesting that in a case of excess zeroes in the dependent variable, the appropriate estimator should be a split-population or zero-inflated model that is in a Poisson form. By revisiting the Elbadawi and Sambanis (2002) study on the determinants

of civil war, applying a zero-inflated Poisson (ZIP) to their data and comparing these results to their probit estimations, differences were found with potentially substantial implications. In light of the findings from this data replication, the greed versus grievance debate is re-evaluated on an updated panel of annual data for 134 countries between the period 1960 to 2013. Using this more appropriate estimator that accounts for excess zeroes that are heterogeneous, the results suggest evidence of substantial differences between the probit and ZIP estimators. A comparison of the results show regressions which use the ZIP model to consistently outperform ordinary probits.

CHAPTER 2

Military Spending, Heterogeneity and Economic Growth

2.1 Introduction

There is a large and growing literature documenting the effects of military spending on economic growth that reflects a continued lack of consensus. This has allowed researchers to revisit earlier analyses and identify definitive effects of military spending which continues to be the subject of considerable debate. With the end of the Cold War came substantial changes in the geopolitical environment, leading to sizeable reductions in worldwide military expenditure. However, in recent years (since 2000), this declining trend has bottomed out and military spending is once again on the increase, albeit drops in the "West" were experienced in the years 2013 and 2014 (SIPRI, 2014). In conjunction with the end of the Cold War was a fall in conflict incidence, a phenomenon that has also increased in recent years.

Pressures to increase military expenditure can be the result of a country's strategic or security needs, while another avenue to such increases can

be thought of as consequences of decisions made by vested interests. These vested interests, commonly known as military industrial complexes, may be individuals, institutions or organisations that specifically profit from defence spending at the cost of the rest of the economy. For example, following Greece's default on its debts and its implementation of austerity measures after the 2008 global recession, it remains the country with the highest defence spending in the EU (SIPRI, 2014). As Greece cut spending on healthcare, salaries and pensions, continued arms procurements and repayments were made to countries like France and Germany (Grebe and Sommer, 2010).

In 2014 the Stockholm International Peace Research Institute (SIPRI) reported that worldwide military expenditure in 2013 reached 1.75 trillion US dollars, representing 2.4 percent of global gross domestic product (GDP) or equivalent to over $250 per person. These figures highlight the economic significance of military expenditure and raise questions regarding its likely impact on development. At a basic level, it is obvious that military spending matters. Witness, for example, the divergent paths of the developing world and the West. Following the recent global recession, while western countries continue to cut military spending amid austerity policies, no such phenomenon was seen in the rest of the developing world. Despite falls in GDP growth and investment, every region and sub-region outside the West continues to increase military spending (SIPRI, 2014). This highlights that often considerations in defence spending are made outside economic conditions.

In an environment where most developing governments has been pushing to increase GDP growth, foreign direct investment and to decrease poverty, many believe that continued pushes to raise military spending can be seen as counter-productive. Some economists argue that military spending helps deal with a country's internal and external treats, provides technology spillovers and employment to the general public, but one may also argue that such spending does come with opportunity costs (Aizenman and Glick, 2006; Dunne, 2012). Resources that have been diverted to military expenditure could be used for other developmental purposes which might improve welfare

by a far greater amount. Such issues are particularly relevant in developing countries as they are more likely to be exposed to poor economic performance or episodes of conflict. Yet, it is these developing economies that continue to drive for higher military expenditures.

While military expenditure and economic growth can be viewed as a relevant and important issues, most empirical estimates of their effects are often contradictory or inconclusive. Some of the confusion and mixed results are due to non-linear relationships between military spending and growth and group heterogeneity within the overall sample. Cross-country studies often hide numerous complex patterns with differences in areas such as levels of security, income, economic growth and conflict experience. These differences can lead to substantial amounts of variation in past empirical studies and thus inconclusive results. Aizenman and Glick (2006) argue that when levels of threat are considered, linear models lead to inconsistent estimates since the relationship between economic growth and military spending is actually non-linear, while Smaldone (2006) suggests that the relationship between military spending and economic growth is heterogeneous reflecting a country's conflict experience.

To further investigate the above mentioned claims, the objective of this chapter is two-fold. First, it explores possible non-linearities between military spending and economic growth. Second, the chapter examines group heterogeneity within the sample of countries and considers the effect of military burden on growth. The general estimation method used here follows a dynamic first order model with fixed effects. The data is based on a post-Cold War balanced panel of 106 countries from 1988 to 2010 and to the author's knowledge, the data set used is the most complete and reliable within the literature. The next section reviews the existing literature on the military spending growth relation. This is followed by an exposition of the growth model based on Dunne et al. (2005), which overcomes some of the limitations of earlier models, and previous and current estimation methods. Section four offers a discussion of the dataset and introduces the variables used in sub-sample stratification. Section five presents the estimation results

of the overall sample and considers issues of non-linearity and group heterogeneity, which specifically evaluates the role different country characteristics have on the military spending growth relation. The final section presents some conclusions.

2.2 Military Expenditure and Growth Nexus

2.2.1 Theoretical Considerations

It has been commonly agreed that a theoretical model is quintessential for any empirical work, but much of economic theory does not provide an explicit role for military spending as a distinct activity and thus no obvious theoretical choice is available. Since there is no agreed theory for economists to agree upon, in order to properly incorporate military spending into economic growth various schools of thought have emerged (Dunne and Coulomb, 2008). These include the Neoclassical, Keynesian, Institutional and Marxist perspectives, which allowed researchers to identify numerous channels linking military expenditure to economic growth and help theorise its potential effects. These different channels can then be grouped into three major categories: demand, supply and security, with its effects considered to either be positive, negative or no relation.

The first theoretical approach linking military spending to economic development is from the dominant neoclassical perspective, which is generally expressed through the supply side channel. This perspective considers the state as a rational actor that balances the security benefits and opportunity costs of military expenditure in order to maximise national interest. Here, military expenditure is seen as a public good and its economic effects are determined by opportunity costs: the trade off between it and other forms of government spending, more commonly known as "guns versus butter". This competition for resources, namely, capital (e.g. physical and human), labour, technology and natural resources result in these being unavailable

for civilian use; hence the opportunity cost of military spending. However, the resultant effect of military expenditure on the economy through the lens the neoclassical approach is still a lively debate. Authors such as Mylonidis (2008) describe crowding out of public and private investment, adverse balance of payment within arms importing countries, inefficient bureaucracies, fewer civilian services and R&D activities are just some of the possible opportunity costs associated with higher levels of military expenditure. Yet, others argue military R&D may result in development of improved technologies with beneficial spillovers into the civilian sector.

In contrast, the Keynesian and Institutional perspective and are associated with both demand and supply side effects. These two approaches see the state as a proactive entity which utilises state funds on military expenditure as a means of increasing output through a Keynesian multiplier effect (Dunne and Uye, 2010). Combining with the Keynesian perspective, the institutionalists focus on high military spending leading to industrial inefficiencies and the development of powerful interest groups (i.e military industrial complex) that benefit from military expenditure. In the presence of ineffective aggregate demand, increases in military expenditure from the demand channel can lead to increased capacity utilisation, higher profits and subsequently rising investment and growth. From the supply side, military expenditure is viewed as an opportunity cost which may crowd of physical and human capital investment. Clearly, the extent of the effects pointed out will differ depending on country characteristics and is often impossible to deduce through theory whether the net effect of military expenditure on output is positive or negative.

Arguments from the Marxist perspective view the creation of larger defence sectors as a way means for capitalist development and escaping from the fall in the rate of profit. By investing in the defence sector, countries delay the collapse of the capitalist mode of production (Coulomb and Bellais, 2008). While military spending has an inherently negative effect on the economy, in a capitalist state that is often characterised as having overproduction and stagnation, military spending contributes towards aggregate

demand without adding to aggregate supply, thus allowing firms to reduce their surplus, sell the goods and realise profits (Gottheil, 1986; Riddle, 1986).

Another perspective comes from the international relations perspective. If there is an absence of international cooperation to reduce political tensions, higher military spending can be used by a country to ensure its own security in the region. Thompson (1974) argued that military expenditure can be economically productive since it enhances a state's security and protects its population and property rights from internal and external threats which will encourage private investment and growth. However, as always, there is a counter-argument suggesting higher military expenditure can have no impact on a states security, but can even worsen it through potentially being dragged into an arms race (i.e. Between Pakistan and India, and Turkey and Greece).[1] Also, where military expenditure is not driven by basic security needs, it is often the result of rent-seeking activities which can potentially provoke damaging conflicts.

As these various theoretical perspectives mentioned above suggest, the question of whether and to what extent military spending has an economically positive or negative effect cannot be resolved by use of anecdotal evidence and historical observations, but instead requires rigorous empirical analysis. The analysis must be able to challenge the numerous estimation problems, provide a consistent picture to the causation of military spending on economic development and can be applied to real world scenarios. It is to this that the literature review now turns.

2.2.2 Related Literature

In applied work, the relationship between military expenditure and development is often restricted to the use of economic growth rather than develop-

[1]Knight et al. (1996) found that for the period 1972-90 higher military spending in the Middle East and Eastern Europe failed to achieve any improvements in security while low levels of military spending in the Western developing countries showed low incidences of major armed conflicts.

ment because of the problems in defining and measuring development. The empirical debate over the relation between military expenditure and growth was started by Benoit (1973, 1978), where he surprised many development economists by presenting a positive cross-country association between military spending and economic growth in least developed countries (LDCs). This led to a large amount of research activity and an impressive build-up of literature that has tended not to support Benoit's initial findings. Opinions on the effects of military spending are often divided among two groups: the 'pro' group that views military spending as a guarantee to peace, security and welfare, while the 'against' group sees such spending as a wasteful enterprise that influences the economy beyond the resources it consumes, especially if it leads to or facilitates conflict. Although the effects of military expenditure have been debated for over 40 years, the answer almost always remains an empirical one. Irrespective of which perspective one takes the topic of military spending is most definitely non-trivial, often leading to important economic consequences for both developing and developed countries.

A number of researchers have tried to survey the existing literature; Ram (1995), Dunne (1996) and Smith (2000) find no empirical regularity, positive or negative, though Smith did indicate that using more sophisticated techniques could lead to a small negative effect in the long run. In the most recent survey of 168 studies, Dunne and Tian (2013) found that increasing the sample size to include more recent studies provided increasingly stronger evidence of a negative effect of military expenditure on growth.[2] A summary of their results can be found in Table 2.1. Dividing the 168 studies into different types, military spending was found to have negative effects on economic growth in 44 and 31% of cross-country and case studies respectively. Only between 20 and 25% of studies found positive effects, while about 40% reported unclear results.[3] There were earlier suggestions by Dunne and Uye (2010) that increasing the proportion of post-cold war data might provide more consistent results and this indeed seems to be the case, with almost 53%

[2]Extends and updates on an earlier survey by (Dunne and Uye, 2010).

[3]"Case studies" refers to single country of small groups of countries and the "unclear" category means mixed or insignificant results.

of post-cold war cross-country studies (e.g. using predominantly post-cold war data) finding a negative military spending effect on growth.

Table 2.1: Summary Results

	Total Number of Studies	Findings *(in percent)* Positive	Negative	Unclear
Type				
Cross-Country	96	19.8	43.8	36.4
Case-Studies	72	25.0	30.6	44.4
Total	168	23.0	38.1	39.8
Pre-end to Cold War				
Cross-Country	60	20.0	38.3	41.7
Case Studies	42	21.4	33.3	45.2
Total	102	21.6	35.3	43.1
Post-Cold War				
Cross-Country	36	19.4	52.8	27.8
Case-Studies	30	30.0	26.7	43.3
Total	66	24.2	40.9	34.9

Source: Dunne and Tian (2013)

As recent studies in the literature, shown in Table 2.1, have started to find more consistent results, there remains concerns regarding group heterogeneity and non-linearity. In considering group heterogeneity, Smaldone (2006) finds that indeed for Africa the relationship between military spending and growth is heterogeneous with differences in the results due to country's experience with conflict. Dunne (2012) provides support to this claim with Looney and McNab (2008) giving further emphasis on the group heterogeneity issue through differences in economic freedom and governance. As for non-linearity, authors such as Yakovlev (2007), Tiwari and Shahbaz (2012) and Stroup and Sharp (2001) find important non-linear relationships between military spending and growth.

Following on from these contributions, this chapter estimates an exoge-

nous growth model for a sample of 106 countries, stratifying into sub-samples to provide a comprehensive and definitive assessment of heterogeneity and non-linearity across income groups, conflict experience, natural resource abundance, net recipients of aid, trade openness and measures of democracy. Conflict experience would seem to be an important potential source of heterogeneity. As mentioned, Smaldone (2006) argued that military burden within Africa generally corresponds to the security realities and affects the relationship between military spending and economic growth. As is common in the literature, conflict is defined as having at least 25 battle-related deaths per year, but a cumulative battle death of over 1 000 throughout the duration of the conflict is also considered.

Natural resource endowment has been investigated as having an impact on conflict and is also a good candidate for a factor that might influence the relationship between military spending and growth. Collier and Hoeffler (2004) found that where rebellions or civil wars are motivated by greed, primary commodity exports can substantially increase conflict risk. They argue that in the presence of natural resource abundance, opportunities arise through extortion and looting of profits for those in control of the resource, thus making conflict or rebellion feasible and perhaps even attractive. Other research suggests similar hypotheses. Sarr et al. (2011) explains that in a resource-rich country, an unchecked ruler can use resources as collateral and facilitate acquisition of loans and loot the economy. It certainly seems reasonable to suggest that resource abundance countries differ in their relation between military spending and growth. Following conventions in the literature, natural resource dependence is measured as the ratio of mineral exports to total exports. A country is considered natural resource dependent if mineral exports constitute more than 25% of a country's total exports, a measure that is consistent with the International Monetary Funds (IMF's) definition of export dependence.

Another potentially important variable is foreign aid. In the conflict literature, Collier and Hoeffler (2004) identify diaspora and their impact on conflict through flows of funds that can support insurrection, while in the

growth literature impacts of aid on development is without consensus. Burnside and Dollar (2000) concluded that aid has a positive impact on growth in developing countries with good policies (fiscal, monetary and trade) and no impact in the presence of poor policies. On the other hand, Easterly et al. (2004) and Hansen and Tarp (2000) rebut Burnside and Dollar (2000)'s claim and find that aid works for countries with poor policies. While there is no consensus regarding the impact of aid on growth, it is recognised that aid fungibility can lead to indiscretionary spending, often in the form of military expenditure. Thus, it is reasonable to suppose that the impact of military spending may differ between countries that are net aid recipients and those that are non-recipients. Aid recipients are divided into three categories of low, medium and high amounts of aid received.

A fourth issue that has been highlighted in the literature is the impact of an economies openness on growth. There is currently no consensus, with proponents of trade openness having a positive effect on development including Edwards (1998), Frankel and Romer (1999) and Dollar and Kraay (2004), while those that find trade openness to have a negative or no effect on growth to be Yanikkaya (2003) and Rodriguez and Rodrik (2000), respectively. There is also a substantial literature on trade and conflict, suggesting countries which trade are less likely to fight (Polachek, 2007). In addition, involvement in arms trade can impact upon economic growth for a given level of military expenditure (Yakovlev, 2007). In 2013, according to SIPRI, the top 6 suppliers of arms in the world (Russia, USA, China, France, UK and Germany) are also within the top 10 of the world's top military spenders. Although a select few countries are involved in arms exports, the majority of the world's economies are arms importers. In the case of trade openness, a more open economy could represent greater net arms imports than the equivalent closed economy. This represents an opportunity cost since resources used for arms imports could be better used for developmental purposes. Trade openness is calculated by taking the sum of a country's imports and exports and dividing that by its GDP. A country is defined as open if it is above the value of the world average and vice versa for a closed economy.

A final issue has to do with political institutions and its impact on military spending. From an armed conflict perspective it has generally been agreed that coherent democracies and harsh authoritarian states have the least civil wars, with the prior being ruled through civil liberties and a choice through voting, while the latter is ruled through extreme repression. As for states most civil war prone, this rests with intermediate regimes such as weak democracies, weak autocracies, transitional or new states (Hegre et al., 2001). A reasonable link can be drawn towards military expenditure and growth. For authoritarian or intermediate states, in order to stay in power, resources are required to be expended on forces to keep its civilians, opposing parties and potential rebels in check. These spending patterns on arms and its impact can indeed differ in comparison to democracies, where resources can be used to promote the welfare of the state. Political institutions is measured using the popular polity variable, differentiation between the state's political position is in the form of a 21-point scale.

2.3 Modelling Military Expenditure and Economic Growth

For the empirical analysis, the model developed by Dunne et al. (2005) is used, whereby the effect of military spending on economic growth is based on the augmented Solow growth model with Harrod-neutral technical progress. Similar to that of Knight et al. (1996), military spending, measured as a share of GDP ($m = M/Y$), is assumed to affect factor productivity via a level effect on the efficiency parameter, which controls Harrod-neutral technical change. Putting it differently, a permanent change in m does not affect the long-run steady-state growth rate, but has the potential to have a permanent effect on per capita income along the steady-state growth path. The share of military spending can also affect the transitory growth rates along the path to the new steady-state equilibrium. To see this, consider an augmented Solow growth model with an aggregate Neoclassical Cobb-Douglas

production function featuring Harrod-neutral technological progress.

$$Y(t) = K(t)^{\alpha}[A(t)L(t)]^{1-\alpha} \tag{2.1}$$

where $\alpha \in [0, 1]$, and t denotes time. Y denotes aggregate real income, K is the real capital stock, L is labour and A is the technology parameter evolving according to:

$$A(t) = A_0 e^{gt} m(t)^{\theta} \tag{2.2}$$

where g is the exogenous rate of Harrod-neutral technical progress and m is the share of military expenditure in total output (GDP). The production function is seen to exhibit constant returns to scale in its two factors: physical capital (K) and productivity augmented labour (AL). Together with the standard Solow model assumptions of perfectly competitive inputs and outputs, exogenous savings rate s, constant labour force growth rate n, and constant depreciation δ, the dynamics of physical capital accumulation can be displayed as:

$$\dot{k}_e(t) = s_k k_e^{\alpha}(t) - [n + g + \delta]\dot{k}_e \Leftrightarrow \frac{\partial \ln k_e}{\partial t} = se^{(\alpha-1)\ln k_e} - (g + n + \delta) \tag{2.3}$$

where $k_e = \frac{K}{AL}$ denotes the effective captial-labour ratio and α is the constant capital-output elasticity. The steady-state level of k_e is then:

$$k_e^* = \left[\frac{s}{n + g + \delta}\right]^{1/(1-\alpha)} \tag{2.4}$$

where the asterisk denotes the steady-state value of the variable. Having found the steady-state level of capital stock, it is now possible to solve for the steady-state value of output. Linearising (2.3) via a truncated Taylor series expansion around the steady-state and substituting (2.4), the result is:[4]

$$\frac{\partial \ln k_e}{\partial t} = (\alpha - 1)(n + g + \delta)[\ln k_e(t) - \ln k_e^*] \tag{2.5}$$

and since $\ln y_e = \ln \frac{Y}{AL} = \alpha \ln k_e$, then one can approximate the transitory dynamic of income per effective worker around the steady-state as:

$$\frac{\partial \ln y_e}{\partial t} = (\alpha - 1)(n + g + \delta)[\ln y_e(t) - \ln y_e^*] \tag{2.6}$$

where the steady state level of output per effective worker is:

$$y_e^* = \left[\frac{s}{n + g + \delta}\right]^{\alpha/(1-\alpha)} \tag{2.7}$$

Equation (2.6) above estimates the transitory dynamics of output per effective worker in the neighbourhood of the steady-state level. Following Dunne et al. (2005) , equation (2.6) is integrated forward from $t - 1$ to t, giving:

$$\ln y_e(t) = e^z \ln y(t-1) + (1 - e^z) \ln y_e^*, \; z \equiv (\alpha - 1)(n + g + \delta) \tag{2.8}$$

Now, using equations (2.2), (2.7) and (2.8), y_e is related to observable per capita income ($y = Y/L$) via:

[4]Re-writing (3) in the form $du/dt = f(u), u = lnk_e$, the linearised form is $f(u^*) + f'(u^*)[u(t) - u^*]$

$$\ln y(t) = e^z \ln y(t-1) + (1-e^z) * \left\{ \ln A_0 + \frac{\alpha}{1-\alpha}[\ln s - \ln(n+g+\delta) \right\}$$

$$+\theta \ln m(t) - e^z \theta \ln m(t-1) + (t-(t-1)e^z)g \tag{2.9}$$

Where z is still equivalent to $(\alpha - 1)(n + g + \delta)$, while θ is the elasticity of steady-state income with respect to the long-run military expenditure share. Equation (2.9) is conceptual and can be adapted to provide the basis for empirical analysis, Dunne et al. (2005) suggest that the dynamic panel specification can now be written in the form:

$$\Delta \ln y_{i,t} = \gamma \ln y_{i,t-1} + \sum_{j=1}^{3} \beta_j \Delta \ln x_{j,i,t} + \sum_{k=1}^{2} \alpha_k \ln x_{k,i,t-1} + \eta_t + \mu_i + \nu_{i,t}$$

$$; i = 1, 2, ..., N; t = 1, 2, ..., T \tag{2.10}$$

where $x_1 = s_K =$ the gross investment as a share of GDP; $x_2 = (n_{i,t}+g+\delta)$ = labour force growth rate plus $(g + \delta)$ which is a constant, assumed to be equal to 0.05[5]; and $x_3 = m_{i,t}$ which is equal to military spending as a share of GDP. The variables x_k represent the lagged variable of military spending and gross investment as a share of GDP respectively. The variable η_t reflects the time specific effects, μ_i represents group specific effects and $\nu_{i,t}$ is the error term. Following from Islam (1995) this chapter treats s and n as variant across countries and time, while taking g and δ to be uniform time-invariant constants and exogenous across time and country.

[5]The assumption that $(g + \delta) = 0.05$ follows from Mankiw et al. (1992); whereby they chose values to match available data and this was supported by Romer (1990).

2.4 Data Description

All the Solow-style regressions estimated here are based on the same balanced panel data set. Starting with the military expenditure dataset of over 150 countries, provided by the Stockholm International Peace Research Institute (SIPRI). Countries were excluded on the basis that a maximum of two missing observations are allowed for the military expenditure variable. The final balanced panel comprises of 106 countries with annual data spanning the period 1988 to 2010. All the variables except for the trend term are in natural log form, including lagged log values for military expenditure, capital stock and real per capita GDP.

The two main variables of concern, real per capita GDP (growth) and military expenditure as a share of GDP are obtained from World Bank and SIPRI respectively. Unlike Islam (1995) or Yakovlev (2007) this chapter uses annual data instead of five-year averages; the motivation being that business cycle effects are important and form part of the long-run determinants of growth. The variable gross-fixed capital formation as a share of GDP is obtained from the World Bank's World Development Indicators (WDI) database and will be used as a measurement of capital stock. Due to difficulties obtaining reliable data for the average growth rate of the working-age population this chapter uses the common alternative of population growth instead, this data is also from the World Bank's WDI.

For the purposes of empirical analysis, indicator variables relating to the specific sub-samples (e.g. income groups, developed and developing countries, conflict experience, natural resource abundance, net recipients of aid, trade openness and political institutions) are used for sample stratifications. The rationale behind using the sample stratification method and indicator variables relate to the nature of the study as well as the type of sub-samples considered. Many of the sub-samples considered (e.g. conflict experience, developed and developing and natural resource abundance) are invariant across time and country and thus cannot be included in the growth regression as categorical variables. Subsequently, the approach is to disaggregate the over-

all sample into smaller sub-samples, which takes into consideration group heterogeneity and non-linearity.

Classifications of countries that are either developed or developing and income groupings are excerpted from the World Bank's WDI database; developed countries are quoted a numerical value of one while all the remaining countries within the sample receive a zero value.[6] In order to homogenise the sample size of the different income groups this chapter combines the definitions of low and low-middle income countries to form low-income countries. High-middle income countries are now defined as middle-income countries, while the definition of high-income countries has been left unchanged.[7] The armed conflict indicator was taken from the Uppsala Conflict Data Programme and International Peace Research Institute Oslo (UCDP/PRIO) database, which also differentiates between civil and interstate wars.[8]

Natural resource abundance, measured by mineral exports as a share of total exports, uses data from Haglund (2011) and the UNCTADstat database. The focus was on six types of fuels and non-fuel minerals, as defined by the Standard International Trade Classification (SITC) codes shown in Table 2.2. The natural resource indicator is divided into three sparate variables, with each variable given a value of one or zero. The first variable (nat) characterises whether a country is natural resource dependent via a combination of fuel and non-fuel minerals; the second variable ($fuel$) indicates whether a country is fuel dependent while the third variable ($non-fuel$) records countries that are non-fuel mineral dependent. A country is considered mineral dependent if its mineral exports constitutes over 25% of total exports.

[6]Country classification for developed and non-developed are taken from the WB.

[7]Income group definitions are also from the WB, economies are divided according to 2010 gross national income (GNI) per capita. The groups are: low-income, $1005 or less; lower-middle income, $1006 to $3975; upper-middle income, $3976-12 275; and high-income, $12 276 or more.

[8]Armed conflict is a combination of either interstate of civil conflict. Interstate conflict is defined as a conflict that occurs between two or more states, while conflict between the government of a state and one or more internal opposition groups without intervention from other states is labelled as a civil conflict. All conflict variables must satisfy the criteria of having more than 25 battle-related deaths in a given year and over 1 000 battle-related deaths since its onset.

Table 2.2: Six Types of Mineral as Classified by SITC Codes

SITC code and description	
SITC 27: Crude fertilizers and crude minerals (excluding coal, petroleum and precious metals)	Non-fuel minerals
SITC 28: Metalliferous ores and metal scrap	
SITC 68: Non-ferrous metals	
SITC 667: Pearls and semi-precious stones	
SITC 971: Gold, non-monetary	
SITC 3: Mineral fuels (including natural gas), lubricants and related materials.	Fuel

Official development assistance (ODA) or aid is taken from the WB WDI. The full sample of countries is initially divided into those that are net ODA recipients compared to those that are not. Since net recipients of aid is measured as a share of GNI, any country that receives on average less than 0.1% of aid as a share of GNI will be considered as non-aid recipients. Aid recipients are then divided further into countries that receive low (less than 1% of GNI), medium (between 1 and 5% of GNI) and high (greater than 3% of GNI) amounts of aid.

Measures of political institutions uses the *polity* variable extracted from the Polity IV database with the variable ranging from -10 (high autocracy) to 10 (high democracy). To create an indicator variable consistent with the others, a *polity* value of less than -3 will be categorised as an autocratic state, values between -3 and 3 (inclusive) will be labelled as an intermediate states, while values of greater than 3 will be seen as a democratic state. Finally, the trade openness variable (*trade*) takes on a value of one for open and zero for closed economies. The imports, exports and GDP figures are recorded on constant US dollars, averaged over the entire 23-year period and deflated using purchasing power parity.

Table 2.3 below provides the summary statistics of the final dataset containing 106 countries over a 23-year period. The sample includes 28 developed countries, 78 developing countries, 30 African countries, 20 Asian and

Oceania countries, 26 European countries, 21 North and South American countries and 9 Middle East countries.[9] In the full sample, 37 percent of all countries have experienced some form of conflict (civil or interstate) between 1988 and 2010. Similarly, 63 percent of the countries receive ODA, almost 36 percent are natural resource dependent and just over 78 percent are considered open economies.

Table 2.3: Summary Statistics

Variable	Variable Description	Mean	Std Dev.
m	Military Spending as % of GDP	2.70	3.71
y	Real GDP per capita	11964	12658
k	Gross fixed capital formation % of GDP	21.28	6.57
pop	Population (in 000's)	50408	156627
Δy	Growth in Real GDP per capita (%)	1.96	4.78
Δm	Growth in Military Spending (%)	-2.20	20.58
Δk	Growth in Gross fixed capital formation (%)	0.13	14.84
$Conflict$	Conflict prevalence	0.37	0.48
$Polity$	Polity IV (-10 to 10)	2.48	0.76
Aid	Countries Receiving ODA (%)	63.2	48.2
Nat	Abundance in Natural Resources (%)	35.8	47.9
$Trade$	Open Economies (%)	78.3	41.2

2.5 Empirical Analysis

In undertaking the empirical analysis of military spending and growth, a major problem has been poor data quality and a lack of exogenous variation within the data. However, since the end of the cold war, data quality and leverage have improved and developments in panel data techniques has helped overcome the limited exogenous variation in the data (Dunne et al., 2005). Panel data methods such as simple fixed effects, random effects and random

[9] A list of countries featured in the chapter can be found in the appendix. Table A1 shows the full list of 106 countries, while tables A2, A3 and A4 display countries in the stratified sub-samples.

coefficient estimators have all been increasingly used. Moreover, as longer time-series become available, dynamic specifications have been introduced into panel data techniques. This, however, has raised a number of issues, as the following example of a simple bivariate dynamic model demonstrates:

$$y_{it} = \alpha_i + \beta x_{jt-1} + \lambda y_{jt-1} + u_{it} \tag{2.11}$$

as equation (2.11) shows, a fixed effects estimator would suffer from lagged dependent variable (y_{it-1}) bias, which will bias the OLS estimator (β) downwards. Apart from the lagged dependent variable bias, there is also a case for heterogeneity bias when the parameters differ over the groups. This resultant heterogeneity bias will bias the estimates of λ upwards. Ways to deal with this potential heterogeneity bias include estimating each equation individually and then taking an average of the individual estimates or using a dynamic model with fixed effects. Another solution is to use a dynamic panel with fixed effects. The long-run estimates of the military spending are likely to be less biased since the estimates of β (downwards) and λ (upwards) work in opposite directions in cancelling out its respective individual effects (Dunne et al., 2002). The estimated general first-order dynamic model will then take the form of:

$$\Delta \ln y_{i,t} = \gamma \ln y_{i,t-1} + \sum_{j=1}^{3} \beta_j \Delta \ln x_{j,i,t} + \sum_{k=1}^{2} \alpha_k \ln x_{k,i,t-1} + \eta_t + \mu_i + \nu_{i,t}$$

$$; i = 1, 2, ..., N; t = 1, 2, ..., T \tag{2.12}$$

where y is GDP per capita, x_1 is gross fixed capital formation as a share of GDP (proxy for investment or capital stock), x_2 is military spending as a share of GDP, x_3 is the population growth rate plus 0.05 or $(n + g + d)$. The re-parameterised general first-order dynamic model is then estimated and the results are presented in Table 2.4, where all variables are in logs (l), Δ represents the change in the variable, $(t-1)$ denotes a lag of one period, the dependent variable in all regressions is Δly and representing the change

in per capita GDP.

The results show a very well defined empirical model, with all the traditional growth variables statistically significant and of the expected signs, a finding that is consistent with Mankiw et al. (1992)'s predictions. The change in log of capital or gross investment (Δlk) is positive and significant; indicating that for the full sample of countries, the higher the investment, the richer the country. The variable log of population growth rate + 0.05 ($lngd$) is negative and significant, pointing towards higher rates of population growth having a negative impact on a country's economy. The lagged level value of per capita GDP ($ly1$) is negative and significant, this, as expected, is the standard result in the empirical growth literature, known as conditional convergence. Moving onto the variable of concern, military expenditure as a share of GDP has a clear negative relationship (in the short and long run) with per capita economic growth. A result which is consistent with recent cross-country studies (Dunne and Tian, 2013).[10]

Considering possible heterogeneity in the sample, Table 2.4 also provides estimation results for developed and developing countries, giving results which are similar to the full sample. In the non-developed country group, there is a negative and significant relation between military expenditure and economic growth in the short and long-run, while for the developed countries this effect is only seen in the short-run with no visible evidence in the long-run. Interestingly, there is also a major difference in the size of the coefficients between developed and developing country groups. The coefficients of military spending in Table 2.4 suggest that defence spending in developing countries are substantially more harmful, about 50 percent, compared to developed countries. The long-run coefficients seems to support this observation with the effect for non-developed countries more than doubling that of the developed countries.[11]

[10]For robustness checks a robust standard error using the Huber/White estimator was used. The significance of the explanatory variables remain unchanged and thus this chapter reports only the normal standard errors in all remaining tables.

[11]The long-run coefficient is calculated according to a general error correction model in the form of $\Delta y_t = \beta_0 + \beta_1 \Delta x_t + \beta_2 x_{t-1} + \alpha_1 y_{t-1} + \varepsilon_t$ where in a steady state equilibrium

Table 2.4: Growth Effects of Military Expenditure

	(1)	(2)	(3)
Sample	All	Developed	Non-Developed
Variables	Δly	Δly	Δly
Δlk	0.070**	0.213**	0.059**
	(0.006)	(0.014)	(0.007)
Δlm	-0.027**	-0.018**	-0.027**
	(0.005)	(0.006)	(0.006)
$lngdpop$	-0.056**	-0.093**	-0.046**
	(0.009)	(0.013)	(0.011)
$ly1$	-0.089**	-0.044**	-0.091**
	(0.008)	(0.012)	(0.009)
$lk1$	0.030**	0.023**	0.026**
	(0.005)	(0.009)	(0.006)
$lm1$	-0.017**	-0.009	-0.018**
	(0.004)	(0.006)	(0.004)
$Constant$	-3.406**	-0.044	-4.459**
	(0.398)	(0.587)	(0.497)
Trend	Yes	Yes	Yes
LR Coefficient	-0.191	-0.097	-0.198
Observations	2148	607	1557
R-squared	0.140	0.375	0.143

Dependent variable: Δly; Standard errors in parenthese; Significance levels: ** p<0.01, * p<0.05, † p<0.1; All standard errors reported are the normal standard errors.

As Dunne (2012) and Pieroni (2009) argue, the effect of military expenditure on growth may well be very different for countries with different income levels, suggesting a non-linear relation. To consider such differences, the full sample is stratified into three different income groups of low, medium and high income, giving the results in Table 2.5. Once again, the empirical growth

$\Delta y_t, \Delta x_t, \varepsilon_t, \beta_0 = 0$, giving a long-run coefficient in a function of $-\frac{\beta_2}{\alpha_1}$.

model is generally well specified across the income groups, with coefficients of the expected sign. For all three income groups, the effect of military burden on growth is negative and significant in the short-run, but in the long-run this pattern is only evident in the low and high-income countries.[12]

Table 2.5: Growth Effects of Military Expenditure, Stratifying for Income

	(1)	(2)	(3)
Sample	Low	Medium	High
Variables	Δly	Δly	Δly
Δlk	0.003	0.163**	0.112**
	(0.010)	(0.011)	(0.013)
Δlm	-0.034**	-0.019*	-0.025**
	(0.009)	(0.008)	(0.007)
$lngdpop$	-0.026**	-0.021	-0.083**
	(0.015)	(0.022)	(0.010)
$ly1$	-0.093**	-0.092**	-0.082**
	(0.013)	(0.013)	(0.013)
$lk1$	0.014†	0.043**	0.021*
	(0.008)	(0.009)	(0.010)
$lm1$	-0.027**	-0.005	-0.020**
	(0.006)	(0.006)	(0.007)
$Constant$	-4.555**	-5.476**	-0.609
	(0.673)	(0.790)	(0.635)
Trend	Yes	Yes	Yes
LR Coefficient	-0.290	-0.054	-0.244
Observations	831	638	695
R-squared	0.128	0.346	0.257

Dependent variable: Δly; Standard errors in parentheses; Significance levels: ** p<0.01, * p<0.05, † p<0.1

[12]The difference in sample size of 88 between the high-income and developed countries are due to countries labelled as high income in terms of per capita GNI but not developed. These 5 countries are Bahrain, Hungary, Kuwait, Oman and Saudi Arabia.

This is an interesting result suggesting that medium income countries might have a particular set of characteristics setting them apart from high and low-income countries. Thus creating a scenario whereby defence spending does not have as severe an opportunity cost. This might be due to persistent experiences of conflict in low income countries, particularly in Africa, or the need to allocate large amounts of resources to welfare schemes in high income countries, cases which are uncommon in medium income countries. A detailed look at the subgroups shows middle-income countries have the highest growth rates and lowest military burden, which potentially leads to systematically different displacement effects of military expenditure. In comparing the coefficients of military spending, the result matches the findings in Table 2.4. Poorer countries seem to have more to lose from military expenditures than richer, more developed countries.

Previous studies on Africa have found differences in the military spending growth relation for countries in conflict and those that are not (Smaldone, 2006). However, the results here of a worldwide sample do not support this. Breaking the full sample into groups of countries that have experienced conflict (39 countries) and those that have not (67 countries) gave the results in Table 2.6. Irrespective of whether a country has experienced conflict, military expenditure has a negative effect on economic growth in both the short and long-run. It is also possible that the type of conflict may be more relevant, since conditions associated to civil conflict may be completely contrasting to that of an interstate conflict.[13] Thus, Table 2.6 also reports results for countries that have experienced civil or interstate conflicts.[14]

The estimation results for countries with civil war experiences (Column 3, Table 5) are consistent with the overall sample, conflict and no conflict groups, with significant negative short and long-run effects of military bur-

[13]Civil conflicts are known to last longer than interstate conflicts. Research by the likes of Fearon (2004) have suggested civil wars to be lasting longer decade by decade and hence may lead to implications on the amount of military spending being spent, which could have direct impacts on an economy.

[14]Over the 23 year period, the 6 countries that have experienced both civil and interstate conflict are: Ethiopia, India, Iran, Pakistan, Peru and United Kingdom

den on economic development. Intriguingly, military burden on countries involved in interstate conflicts seem to have no effect on growth. This might be due to the various distinctions between civil and interstate wars as discussed in Lemke and Cunningham (2009). The consequences of military spending on economic growth would be different for a country that is invaded than a country which fights in an another country or participates in large multilateral operations.

Table 2.6: Growth Effects of Military Expenditure, Stratifying for Conflict

	(1)	(2)	(3)	(4)
Sample	Conflict	No Conflict	Civil	Interstate
Variables	Δly	Δly	Δly	Δly
Δlk	0.045**	0.087**	0.046**	0.144**
	(0.010)	(0.008)	(0.010)	(0.023)
Δlm	-0.028**	-0.025**	-0.027**	-0.009
	(0.007)	(0.007)	(0.008)	(0.010)
$lngdpop$	-0.036**	-0.075**	-0.029*	-0.151**
	(0.013)	(0.012)	(0.014)	(0.040)
$ly1$	-0.118**	-0.067**	-0.107**	-0.124**
	(0.013)	(0.009)	(0.014)	(0.024)
$lk1$	0.030**	0.029**	0.029*	0.067**
	(0.008)	(0.006)	(0.009)	(0.019)
$lm1$	-0.021**	-0.018**	-0.019**	-0.006
	(0.005)	(0.005)	(0.005)	(0.006)
$Constant$	-5.897**	-1.450**	-5.998**	-5.112**
	(0.606)	(0.550)	(0.678)	(1.073)
Trend	Yes	Yes	Yes	Yes
LR Coefficient	-0.178	-0.269	-0.178	-0.048
Observations	775	1389	695	228
R-squared	0.193	0.138	0.257	0.355

Dependent variable: Δly; Standard errors in parentheses; Significance levels: ** p<0.01, * p<0.05, † p<0.1

While military expenditure may have a universal negative effect on growth for both conflict and non-conflict countries, there could be a different effect on countries at different income levels. To do this, the next step investigates the 38 countries that have experienced conflict, grouping into low, medium and high income countries. These results can be found in Table A5 in the appendix, but due to lack of observations for medium and high-income groups the results should be analysed with caution. Although defence spending remain negative and significant for low and high-income conflict afflicted countries, medium income countries continue to show insignificant effects, irrespective of conflict experience. A comparison of the coefficients in Tables 2.6 and A5 show that for high income countries the military burden is more than three times larger than that of the conflict affected low-income countries and which in turn are both larger than the overall conflict and civil war group. This suggests that while military spending is marginally more harmful for countries in conflict as compared to not in conflict, its damaging effect is even greater for low-income countries involved in conflict and greatest in high-income conflict affected countries.

Given the potential for various other heterogeneous effects in the sample, possible differences in natural resource abundance, net aid received, trade openness and political institutions are explored. These results are given in a summary table below (Table 2.7). Since the coefficients of the general Solow control variables remained consistent throughout the different stratifications, only the coefficient of interest, military spending in the short and long-run, are reported.

To consider the possible impact of natural resource dependence, the UNCTADstat database was used to divide the full sample into 38 countries that are resource dependent and 68 countries that are not resource dependent. Table 2.7 shows military burden to have a negative and significant short and long-run effect on growth for both countries with or without natural resources. An interesting outcome of the natural resource stratification shows the size of the military spending coefficients to be substantially larger for the no natural resource group as compared to the resource abundant group.

The initial rationale for splitting the sample according to natural resource abundance was to assess the hypothesis that resource rich countries spend on average more on military than non-resource rich countries.[15]

Estimates of the mean show that resource rich countries allocate on average 3.6 percent of their GDP to military expenditure, while non-resource rich countries spend only 2.2 percent of the GDP on the military. This 1.4 percent is statistically significant. While on average natural resource abundant countries spend more on the military than non-natural resource abundant countries, the negative effect as illustrated in Table 2.7 is less for the resource abundant countries. There are various reasonable explanations for this result. One can think of resource abundance potentially making military burden more affordable or that, indirectly, a secure natural resource sector through military protection is less harmful to the economy than one that is constantly being fought over.

Allowing for differences in the type of natural resource, the resource abundant group is divided into those that are resource rich in fuel and those rich in non-fuel minerals, with estimates showing a clear distinction. While the results for the fuel resource rich countries are consistent with the overall regressions, military expenditure for non-fuel resource rich countries is estimated to have no effect on growth in the short or long-run. This would suggest that oil economies are driving the negative effects of military burden in the estimates of natural resource abundant countries.

Moving to consider the possible impact of aid, Table 2.7 also illustrates results for countries that receive aid and those that do not, while further stratifying the ODA recipients into low, medium and high aid groups. Again, the results suggest defence expenditure having a negative and significant short and long-run effect, irrespective of whether a country receives foreign development aid. Although this holds true for countries receiving medium and high levels of aid, no such effect is seen for those receiving low levels of aid. Furthermore, the negative coefficients of military burden in the short

[15]Military spending can be seen as a way to help the incumbent leader maintain control the resource rich areas and continue to extract rents.

and long-run increase in size as a country receives higher levels of aid. This may be indicative of poorer countries receiving the most aid often having more to lose when government allocates resources to the military instead of development. Moreover, it could also suggest a potential for indiscretionary spending as a result of receiving large amounts development assistance.

Table 2.7: Summary Results for Military Burden on Economic Growth

	(1)	(2)	(3)
Variables	Δlm	$lm1$	LR Coefficient
Natural Resource	-0.021**	-0.011*	-0.083
No Resource	-0.028**	-0.021**	-0.328
Fuel	-0.044**	-0.029**	-0.269
Non-Fuel	-0.001	-0.002	-0.013
Aid	-0.028**	-0.018**	-0.170
No Aid	-0.023**	-0.016*	-0.246
Low Aid	-0.001	-0.010†	-0.111
Medium Aid	-0.031**	-0.022**	-0.186
High Aid	-0.035**	-0.032**	-0.337
Open	-0.033**	-0.024**	-0.233
Closed	-0.013	-0.008	-0.129
Autocratic	-0.027†	-0.008	-0.114
Intermediate	-0.052**	-0.041**	-0.318
Democratic	-0.012*	-0.008*	-0.113

Dependent variable: Δly; Standard errors in parentheses; Significance levels: ** p<0.01, * p<0.05, † p<0.1

In trying to understand why military expenditure has no adverse effect on low aid recipient countries, the sample was disaggregated by income group.

Of the 18 countries that received low levels of aid, 13 were medium income countries, a group that has been consistently found in this chapter to have no adverse military burden effects. Unsurprisingly, such a high proportion of medium income countries in the low-aid recipient group would no doubt push military spending to be insignificant.

Another potential source of heterogeneity is trade openness.[16] Given that the majority of countries in the world are net arms importers, a more open economy could represent a larger share of arms imports than closed economies, leading to greater opportunity costs on development. Comparing mean estimates of military burden for open (2.77 percent of GDP) and closed (2.45 percent of GDP) economies show that indeed countries which trade more spend more on the military, a difference that is statistically significant. The estimation results in Table 2.7 exemplify military burden to have a striking difference between open and closed economies. While for open economies arms expenditure is found to have a negative and significant short and long-run effect on growth, no such effects are seen for closed economies. These differences are further supported when the average openness measure is replaced with year specific measures of openness (i.e year 2000 or 2010).[17]

Finally, the impact of political institutions are considered. The coefficient estimates in Table 2.7 provide valuable insight on the importance political institutions have on military burden. Although, as expected, military spending as a share of GDP is greatest in autocratic states (4.76 percent of GDP) as compared to intermediate (2.61 percent of GDP) or democratic (2.21 percent of GDP) states, its impact on growth is not significant. Interestingly, this chapter finds military expenditure to only have a negative and significant growth effect on intermediate and democratic states, with a substantially large adverse effect estimated for the intermediate group.

[16]Since one might expect nature of military spending to be entirely different for a country that is a net arms exporter compared to a net arms importer, stratification according to arms importers and exporters were considered as an alternative. However, of the 106 country sample only nine were classified as net arms exporters, thus providing insufficient observations for any meaningful regression analysis.

[17]See appendix Table A6 for full estimation results

How might this result be explained? For autocratic states, political and economic stability is maintained through military force. Military spending, while an opportunity cost, may be seen as necessary in order preserve political power, order and some form economic development. On opposite end of the spectrum, democratic states do not need the military to keep political and economic power. In this case, military expenditure for democratic states contains a greater opportunity cost than autocratic states, hence the negative and significant coefficients seen in Table 2.7. As for intermediate states, closer analysis suggests this group to have the most volatile economy and political situation, the lowest growth rates, receive the most amount of ODA and has the highest proportion of countries with a history of violent conflict (62 percent of all intermediate states in the sample have experienced some form of violent conflict). Countries which are most prone to conflict and have the most precarious political and economic situations may indeed have the most to lose in terms of reallocating resources away from development and towards the military, a result which is reflected in the regressions. This negative impact of military spending (short and long-run) is also the largest compared to all the other estimations.

2.6 Conclusion

Military expenditure by governments is indeed important in the influence it has, especially when it leads to or facilitates conflict. As a result, the economic impact of such spending is of great concern. In this chapter, the link between military expenditure and economic growth is explored. Using a comprehensive post-cold war balanced panel data set for the period 1988 to 2010, a modelling framework suggested by Dunne et al. (2005) and sample stratification, concerns of heterogeneity and non-linearity are considered. The estimation results using a dynamic panel approach with fixed effects provide strong support for the negative impact of military burden on growth in both the short and long-run.

When the overall sample was stratified into different sub-groups, it provided valuable insight into the relationship between military expenditure and economic growth. Grouping countries into developed and developing gave results similar to the overall group, only the long-run effect for developed countries was insignificant. Consistent results were observed when countries were broken into the three income groups, with the short-run coefficient estimate negative and significant for all three groups and the long-run estimate negative and significant for the low and high-income groups. A comparison across the different income and development sub-samples suggests that military spending, while harmful to growth, is particularly more harmful to poorer and less developed countries than richer countries.

While the relationship between military spending and growth for conflict and non-conflict affected countries were negative and significant, expected differences in the effects of military burden on growth in civil and interstate wars was quite apparent. When the type of conflict was considered only the civil conflict group showed any negative and significant results. Other group stratifications by natural resource abundance, net aid received, trade openness and political institutions were considered, giving generally consistent negative and significant results, but also with specific sub-samples showing no effects.

The results in this chapter provide a comprehensive overview on the importance of sample heterogeneity and non-linearity. It seems as though in a post-cold war setting, a consensus is developing whereby military spending is estimated to have an adverse effect on economic growth. While a compelling conclusion can be drawn across countries, care is needed in applying this finding to individual countries as some country groupings showed differing results. Countries characterised as being either middle income, non-fuel natural resource abundant, low-aid recipients, closed economies, autocratic or democratic showed military expenditure as having no significant burden on the economy. As a final note, the most striking aspect of this chapter is that across all the country groups investigated, there were no evidence of military expenditure having any positive and significant growth effects.

CHAPTER 3

Conflict, Economic Growth and Spillover Effects in Africa

3.1 Introduction

Conflict has been a common and persistent phenomenon in recent history, afflicting between 30 and 50% of all nations, depending on which definition is used and lasting longer decade-by-decade[1]. These conflicts and its associated costs can be considered to have a disproportionate effect on poorer countries. As historical evidence suggests, the poorest countries in urgent need of economic development are often the ones embroiled in violent fighting and to devastating effects (Blattman and Miguel, 2010). In Africa, the world's poorest continent, more than 80% of countries have been embroiled in some form of violent conflict since 1960, with 30% having experienced at least ten years of conflict during this period. These wars range from mild skirmishes in countries such as Burkina Faso to large scale battles and massacres in the likes

[1]Conflicts that count more than 1 000 battle deaths and those that count at least twenty-five battle deaths.

of Rwanda and Sudan. In Rwanda, for example, over 20% of the population moved into poverty following the genocide (Justino and Verwimp, 2006). An even worse case was observed in Sudan. Labelled as one of the longest and deadliest civil wars, the conflict between Sudan's North and South led to over 2 million deaths, 5 million being displaced and hundreds of thousands abducted and subjected to slavery (Deng, 2001). Collier et al. (2003) argue that these disproportionate and destructive effects may be so great that it could account for the income gap between the world's richest and poorest countries. Thus, this makes understanding the costs of conflict an important developmental concern.

Although a large literature has been developed in order to understand what leads to conflict (see Collier and Hoeffler, 2004; Fearon and Laitin, 2003), there have been relatively few attempts to try and evaluate its costs and even fewer to consider the impact of conflict on economic growth (Dunne, 2013). More recently, there has been a recognition that the effects of conflict can range further than the host nation and affect neighbour countries (Salehyan and Gleditsch, 2006; Black, 2013; Bosker and Ree, 2014). A literature has since developed to look at these conflict spillovers with de Groot (2010) following the work of Murdoch and Sandler (2002b,a, 2004) and coming to some different conclusions.

This move to assess conflict spillovers is important but it has been limited to using geographic distance as a spillover measurement. Instead, spatial econometric studies should consider other factors of distance such as political and economic similarities (Beck et al., 2006). The potential importance of similarities and differences in these factors to determine the impact of one country's conflict on another has been considered in the literature on the determinants of conflict, but not in the cost of conflict. Just like Watts and Strogatz (1998)'s argument that two distinct people may be "close" in that they share a common acquaintance, countrys that are far away may be "close" if they share a common economic, political or cultural traits.

This chapter contributes to the literature by analysing the spillover effects of conflict in Africa for the period 1960 to 2010 and develops a measure of dis-

tance to account for not simply geographic distance, but also political and economic characteristics. The next section considers the literature on the spillover effects of conflict and suggests an extension to the existing studies which may yield more realistic results. Section three then presents the theoretical framework and the construction of the distance matrices. The data set and empirical method are described in section four, while the estimation results can be found in section five. The sixth and final section provides some conclusions.

3.2 Spillover Effects of Conflict

While there is a substantial literature on the economics of civil conflict, the majority of this has been focused on the determinants and duration of civil wars (Collier and Hoeffler, 2004; Collier et al., 2004; Fearon, 2004). A more limited literature has considered the economic effects of conflict, with a number of studies evaluating the costs of conflict Dunne (2013). In most cases, these studies have focused on the economic effects of the country in which the conflict is taking place (see Collier (1999) and Gyimah-Brempong and Corley (2005)). Given that it is highly unlikely for the consequences of armed conflict to be restricted to the host nation, it is surprising that only a small number of studies such as Murdoch and Sandler (2002a,b, 2004) and de Groot (2010) have tried to consider its wider economic effects.

It was Murdoch and Sandler (2002a) who initially took the important step in recognising the likely significance of spillover effects on neighbouring countries, considering directly contiguous countries (e.g. those sharing a border with the host nation). Using a basic Solow growth model and adding domestic and adjacent conflicts, they found that for a worldwide sample of 84 countries during the period 1960 to 1990, civil wars had a significant negative influence on the steady-state level of GDP per capita for both the conflict afflicted country and its neighbours. Moreover, they note that while part of the negative civil war effect works on growth through the classical

channels of capital and labour, the largest effect is found to come through the unobserved, country specific, channel.

In two subsequent papers, Murdoch and Sandler (2002a, 2004) develops their initial work, varying in time periods, country samples and the definition of contiguity. Using the Gleditsch and Ward (2001) minimum distance between nations dataset, they constructed matrices to measure whether a country is within a specific distance of nearest approach. In their (2002b) paper, for a worldwide sample, Murdoch and Sandler find that the effects of civil conflict is felt over a distance of 800 km, but their (2004) analysis on continental heterogeneity concludes that different regions have different minimum distances. Civil conflicts in Africa had the shortest spillover distance of 100 km, whilst in Latin America and Asia an episode of conflict can have a spillover distance of 300 and 500 km, respectively. In all three papers the long-run effects of civil war were insignificant, which they attribute to Organski and Kugler (1980)'s phoenix effect, while in the short-run civil wars were were found to have a negative and significant growth effect on both the host and neighbouring countries.[2]

Following from Murdoch and Sandler's initial contributions, de Groot (2010) develops the analysis by proposing a change to the estimation process. Firstly he argues that Murdoch and Sandler's theoretical model restricts spillover effects to be uni-dimensional and thus lacks the flexibility to estimate a "bounce back" effect that exists between contiguous states.[3] Distinguishing between primary neighbours (contiguous states) and secondary neighbours (non-contiguous states) within a set distance threshold will allow for both uni and multi-dimensional spillover effects to be captured. Secondly, by replacing the dummy variable for contiguity with the actual minimum dis-

[2]The phoenix effect is named after the metaphor of a phoenix rising from the ashes, symbolising that for a post-conflict society, their GDP per capita may be at such a low base that they are able to rebound quickly and reach their steady-state growth path. This follows the same link as Barro and Sala-i Martin (1992) conditional convergence theorem.

[3]This "bounce back" effect describes the ability for the spillover effects to flow back and forth from the host country and its neighbours. This is unlike Murdoch and Sandler's work where they assume the spillover to only flow from the conflict afflicted country to their neighbours.

tance between countries it gave a more satisfactory and continuous measure of spillover. Using data for Africa from the period 1960 to 2000, de Groot finds that the distinction between primary and secondary neighbours led to very different conclusions. Rather than the general negative growth effect from conflict on all neighbours, de Groot suggests that there could potentially be a growth trade-off that benefits countries close to the conflict and not contiguous (e.g. secondary neighbours), but punishes those that are directly contiguous (e.g. primary neighbours). In addition, whereas previous work focused on civil wars, de Groot considered all forms of conflict and found the results to be consistent.

While the contribution of de Groot (2010) adds further refinement to the literature, a number of developments suggest that this issue is worth revisiting. Firstly, more data has become available, both in terms of quality and quantity. Secondly, the use of five-year averages in all of the above mentioned studies is questioned, as it does not allow conflicts that last one year to be distinguished from ones lasting more than one year and cannot pick up more than one episode of conflict during a five year period. Thirdly, the political science literature has raised the issue of whether physical distance measures are adequate in assessing spillover effects. Conley and Ligon (2002) uses different transportation costs (e.g. UPS shipping costs and airfare) to show that cross-country growth spillovers are more noticeable than simply using geographical distance, while Beck et al. (2006) suggest that spatial econometric work in political economy must consider not only geographical distance but also political and economic distances, such as trade or democracy.

In the case of Africa, a region with numerous political, economic and historic similarities (e.g. type of ruler, colonialism, natural resource abundance and trade) and one that has been plagued with long-lasting conflicts, this seems a particularly important issue. Thus, in light of the identified shortcomings in the literature and innovations from other literatures, this chapter represents an opportunity to fill the current research gap by updating the data set, using annual observations and estimating conflict spillovers using not only geographic distance, but also political and economic distance.

3.3 Theoretical Framework

Following previous studies, the basic theoretical model used to estimate the effects of a conflict on economic growth is based on the classic Solow (1956) model, augmented to include human capital (Mankiw et al., 1992). This model features a Cobb-Douglas production function for diminishing returns (e.g. decreasing marginal product) in labour (L), physical (K) and human capital (H). Constant returns to scale characterises the production function so that proportional increases in inputs leads to proportional increases in output, while along the steady state growth path, savings equals investment in physical and human capital. In order to determine the empirical effects of conflict on economic growth, the model is further augmented to include conflict experience within home and neighbouring countries, via the technology parameter (A). The human capital augmented production function featuring a Harrod-neutral technical progress can be written as:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} [A(t)L(t)]^{1-\alpha-\beta}, 0 < \alpha + \beta < 1 \tag{3.1}$$

where α and β are the elasticities of output with respect to physical and human capital respectively. $Y(t)$ denotes output at time t, $K(t)$ is physical capital, $H(t)$ is stock of human capital and $A(t)$ is the technology parameter with output elasticity of $(1 - \alpha - \beta)$. Labour is assumed to grow at an exogenous growth rate of n, technical progress will grow at the exogenous rate of g and both physical and human capital will depreciate at the identical rate δ. By dividing both sides of equation (3.1) by effective labour (AL), it gives an expression in terms of income per effective worker ($y = Y/AL$), that equals:

$$y(t) = k(t)^{\alpha} h(t)^{\beta} \tag{3.2}$$

with $k = K/AL$ and $h = H/AL$ in quantities per effective worker at time

t. The model is solved by determining the transition equations of k and h, solving for the steady-state levels of k, h and y and log-linearising (see Mankiw et al. (1992) for a full derivation). This gives a model that can be empirically parameterised as the following:

$$y(t) = \beta_0 + \beta_1 \ln(y_0) + \beta_2 \ln(s_k) + \beta_3 \ln(s_h) + \beta_4 \ln(n + g + \delta) \tag{3.3}$$

where $y(t)$ is the growth rate of income per capita at time t, ln denotes the natural logarithm, y_0 is the initial income level of income per capita, s_k is the investment in physical capital, s_h is the level human capital, n is the growth rate of population, g is the growth rate of technical progress and δ is the rate of depreciation.

Theoretically, growth in per capita income from the augmented Solow model, shown in equation (3.3), depends positively on investment in physical and human capital, but falls with increases in $(n + g + \delta)$ or higher initial levels of income per capita (y_0).[4] An increase in the natural rate of labour growth (n) or labour efficiency (g) raises the denominator of the dependent variable (i.e. income per capita) and thus reducing its level. Similarly, depreciation limits income growth through reductions in the growth of physical and human capital as this decline must be offset overtime by a positive accumulation. If the initial level or previous period's income per capita has a negative influence on economic growth, this implies that countries with a lower GDP, ceteris paribus, will growth faster suggesting conditional convergence (Barro, 1991). Poorer countries with low ratios of physical and human capital have higher marginal products with their respective capital as compared to richer countries and thereby grow at higher rates. In line with historical literature, the theory of convergence has been crucial in investigating the impact of conflict on economic growth. Following a conflict, a country can be considered as starting from a relatively low level of income per capita, whereby it then

[4] y_0 denotes initial income, but in annual data, this also represents income in the previous period (e.g. a lagged dependent variable).

catches up through convergence. Organski and Kugler (1980) labelled this the "Phoenix" effect as countries decimated by war rise up from the ashes to record substantial growth rates in the post-conflict years.

There are other ways in which conflict can influence growth, especially when considering the influence of neighbouring country conflicts on economic growth. In defining the different effects resulting from armed conflict, this chapter follows from de Groot (2010) and divides countries in three types: host nations, primary or directly contiguous neighbours, and secondary neighbours or nations that are near a conflict but not directly contiguous to it.

Conflict can influence home and neighbouring country growth through five theoretical channels with its effects summarised in Table 3.1. The first is through the destruction of capital. This destruction of physical capital mainly applies to host nations and through collateral damage on primary neighbours, with secondary neighbours likely to suffer little to no collateral damage. This implies that the further a country is from the conflict origin, the lower the negative influence it has, with a potential to have no effect. Conflict may also affect foreign direct investment (FDI) flowing to the region due to higher perceived risk, which will negatively affect host nations and primary neighbours. The influence it has on secondary neighbours is debated since apart from the potential decrease in investment, the increase of perceived risk in conflict afflicted nations and primary neighbours could lead to relatively more attractive investment opportunities appearing in secondary neighbours.

The second channel is labour and human capital, with its largest effect likely to be destruction and displacement of productive labour and the reassignment of labour to less productive activities (e.g. border patrols, management of refugees or soldiering). Mirroring the capital channel, primary neighbours may to an extent experience the same negative impact as host nations. An addition to these effects is the influence of refugees from the conflict region, with primary neighbours bearing the bulk of refugee inflows. This is likely to be costly, reducing their income per capita in the short run.

In the long run, the effect is unclear, as a portion of the negative effect can be cancelled out by the positive inflow of human and physical capital some refugees bring, but also a worsening through conflict diffusion (Salehyan and Gleditsch, 2006).[5] On the other hand, secondary neighbours are less likely to be affected and when they are, it is possible that those refugees who are able to cross multiple borders carry higher capital than usual, which can be actually be beneficial.

Channel three is trade. In a host country afflicted with conflict, both domestic and international trade is likely to be negatively affected, which can directly harm economic growth. This could have a substantial effect on primary neighbours since diversion of trade flows with the host country will also curb economic growth. However, primary neighbours can negate part of the negative effect by choosing to substitute or redirect trade to the host countries secondary neighbours or their primary neighbours. Conflict may have a large regional affect on trade, which also harms secondary neighbours, but the redirection of primary neighbour trade could provide new trade opportunities for secondary neighbours, which can increase their economic growth (de Groot, 2010).

A fourth channel is the reallocation of resources to less productive activities. This can include efforts to quell local conflicts or bolster defence spending in order to defend territorial borders. In the case of increased defence spending, resources must be diverted from productive activities and will have an opportunity cost on economic growth (Dunne and Tian, 2015). For the host nation and primary neighbours, activities such as border patrols, deployment of personnel and resources to manage the inflow of refugees have a clear cost, but there is little rationale to assume that secondary neighbours would also have to reallocate resources away from productive activities.[6] The final channel through which conflict distorts economic growth is the potential

[5]Refugees may facilitate in the transnational movement of arms, combatants and ideologies that may be conducive to civil conflict.

[6]An exception to this case would be if the host country, primary and secondary neighbours are part of a security web. While this case is interesting, it is beyond the scope of this chapter and would rather provide an interesting avenue for future research.

spillover effect of conflict itself (Sambanis, 2002). This can be significant for primary neighbours, particularly if they end up getting dragged into host nations conflicts, but the effect on secondary neighbours is likely to be minimal (Bosker and Ree, 2014).

Table 3.1: Effects of Conflict on Types of Countries and its Spillover Channels

Spillover Channels	Host Nation	Pri. Neighbour	Sec. Neigbour
P. Capital	-ve effect	-ve effect	-ve, no effect, +ve
Labour & H. Capital	-ve effect	-ve, no effect	-ve, no effect, +ve
Trade	-ve effect	-ve, no effect	-ve, no effect, +ve
Resource Allocation	-ve effect	-ve effect	no effect
Conflict	-ve effect	-ve, no effect	-ve, no effect

Notes: P = Physical; H = Human; -ve = negative; +ve = positive

While it is obvious that the host country is likely to experience a negative growth shock as a result of conflict, the impact on primary and secondary neighbours can be considered different. Primary neighbours are expected to experience either negative or no growth shock from a host country's conflict, while secondary neighbours can be deliberated to suffer limited or no drawbacks from a host country's conflict and potentially reap certain spillover benefits. Given that the spillover effects vary depending on the channel and type of country, the overall effect can only be determined empirically. To augment the growth model for this purpose, variables are introduced to capture host country conflict and primary and secondary neighbour conflicts, which is in-turn weighted to reflect distance. The growth equation which includes the different types of distance contiguity matrices can be written as:

$$\begin{aligned}\Delta \ln y = \alpha_0 + \beta_1 \ln(y_{0,i}) + \beta_2 \ln(s_{k,i,t}) + \beta_3 \ln(s_{h,i,t}) + \beta_4 \ln(n+g+\delta) \\ +\beta_5(conf_{i,t}) + \beta_6 W_{pri}(conf_{pri,i,t}) + \beta_7 W_{\text{sec}}(conf_{\text{sec},i,t}) + \varepsilon_{i,t} \quad (3.4)\end{aligned}$$

where $conf$ is a measure of conflict experience, while W_{pri} and W_{sec} are weighted contiguity matrices of primary and secondary contiguity respectively.

Although most work within the conflict literature has made a clear distinction between civil and interstate conflict, Gleditsch (2007) makes a compelling argument that such events are at times not distinctively different, particularly when looking at spillover costs, thus both civil and interstate conflicts are considered. Keeping with the literature, a host country conflict is recorded as a dummy variable and primary neighbour contiguity matrices are constructed using two approaches. Firstly, using a dummy variable approach, a value of 1 is given to countries sharing a border with the host nation and 0 otherwise. Additionally, a border length approach is implemented, where border distance between countries is used as a matrix element. For primary neighbour weights, the dummy variable and border length are divided by the sum of all primary neighbours and the total distance of the host country's border length respectively. In the border length matrix, this means the longer the border length between two countries, the larger the potential spillover effect. For secondary neighbours, a dummy variable is used to capture all secondary neighbours (not directly contiguous) within a 1 000 kilometre radius, with an alternative measure using exact geographical distance of the closest route between the host country and all secondary neighbours up to 1 000 kilometres.

Specifically, with the minimum distance method, secondary neighbour weights are constructed by taking the 1 000 kilometre radius, less the minimum distance between the two countries, which is then divided by the sum of the minimum distances of all secondary neighbours for the host country. This can be represented as:

$$W_{\text{sec}} = \frac{1000 - \delta_{ij}}{\sum_j \delta_{ij}} \tag{3.5}$$

where δ represents the distance between countries i and j, country i would be the host nation and j a secondary neighbour. Thus, the further a secondary neighbour is from the host nation, the small is the spillover effect.[7]

[7]A graphical example of on the definition of primary and secondary neighbours can be found in figure A1 in the Appendix. Primary neighbours share a border with the host

As discussed earlier, a strong case has been made recently for moving beyond simple geographic distance. It is likely that countries with similar characteristics and links will have more impact on each other than closer countries with less in common. To measure this political and economic distance, democracy and trade measures were taken from the Polity IV and World Bank's World Integrated Trade Solution (WITS) respectively.[8]

Using a 21-point democracy scale, countries that are politically similar will be weighted more heavily than countries with little political similarity. To create this matrix, the host country's polity score is divided by each of its neighbours polity scores, giving each neighbour an individual ratio. These ratios are then divided by the sum of all the host country's neighbours ratios to create country specific weights. This weight measures how politically different the host nation is from each of its neighbours. For example, the average polity score for Algeria (a host country) is 5.28, its two primary neighbours Mali and Mauritania have polity scores of 9.25 and 4.96 respectively. In this case, Algeria's polity ratio to its primary neighbours will be 0.57 (5.28/9.25 = 0.57) and 1.06 respectively. These ratios are then divided by the sum of the ratios (0.57+1.06 = 1.63) to get political distances of Mali and Mauritania to Algeria. Since Mali is less politically similar to Algeria than Mauritania, its weight of 0.35 (0.57/1.63 = 0.35) will be much smaller than Mauritania's 0.65 (1.06/1.63 = 0.65). Thus Mali will considered further away to Algeria than Mauritania and a conflict in Mali will have a lower spillover effect than one occurring in Mauritania.

The construction of economic distance matrices follows very closely from the border length approach. Using bilateral trade, the spillover effect of a host nation's conflict will be weighted more heavily to larger trading partners than smaller trading partners. For the host nation, the bilateral trade to each primary neighbour is divided by the sum the host nation's bilateral trade to

nation, while a secondary neighbour are those who are within a 1 000km radius of the host nation, but do not share a border.

[8]As suggested by Jaggers and Gurr (1995) the Polity IV variable is reworked to a full 21 point institutionalised democracy scale and trade is measured as average bilateral trade between host and neighbouring countries.

all primary neighbours. This means that the more the host nation trades with a primary neighbour, the closer they are and the larger spillover effect from a potential conflict will be. The political and economic distance matrices are each used in conjunction with geographic distance matrices to create weighted matrices that account for economic or political similarities across geographical space. A combined matrix is also created where political and economic distance is added to geographic geographic. All weighted matrices are all row standardised.

Overall, the inclusion of the trade and democracy variables should provide more realistic estimation results than simple geographic distance measures. Spillover effects resulting from conflict are likely to be very different for countries that have high amounts of economic integration (proxied by bilateral trade) with the conflict afflicted country than a country with minimal economic relations. Politically, countries that are democratically similar will be more institutionally linked and also be affected differently as compared to politically dissimilar countries.

3.4 Data and Empirical Methods

Data for empirical analysis are taken from four sources, GDP per capita, investment and population from the Penn World Tables version 7.1; education data from Barro and Lee (2012) and Penn World Tables version 8.0; and measures of armed conflict comes from the UCDP/PRIO Armed conflict Database, updated to 2010 by Themner and Wallensteen (2011).

Instead of using five-year averages and averages over the entire sample period to measure short and long-run effects respectively, as the earlier papers, a panel of annual data for the period 1960 to 2010 was constructed featuring 36 countries. The dependent variable, $\Delta \ln y$, is defined as $(ln(y1) - ln(y0))$ and represents annual per capita GDP growth.[9] A similar approach is used

[9]It should be mentioned that standard sources of data for African GDP have been found to understate both the level and growth rate (Young, 2012). This however, is a problem

for investment, which represents growth in the annual share of investment. As in other studies $(g + \delta)$ is assumed to equal 0.05 and added to population growth to form the term $(n + g + \delta)$. Amalgamating the Penn World Table 8.0's index of human capital, which is measured annually, with the Barro and Lee (2012) education data set, which is measured every five years, gave an annual measure of education attainment in secondary schooling as a percentage of the population of the age of 25.

To consider if variations in conflict type matter, the conflict indicator variable is split into three categories. The first conflict variable "*conflict*" contains all conflicts (civil and interstate) recorded in the dataset to have at least 25 battle related deaths per year, the second variable "*intense*", includes only those conflicts that have at least 1 000 battle related deaths per year and finally, the variable "*civil*" comprise only intrastate conflicts of more than 25 battle related deaths. Conflict duration, measured in months of conflict in a calendar year, is also used to assess whether conflict length matters.

A combination of CIA World Factbook and Gleditsch and Ward (2001)'s minimum distance dataset was used to construct the different geographical weight matrices, and these weight matrices were cross checked for consistency with those used in (de Groot, 2010). The political and economic weight matrices are constructed using Polity IV and World Bank's WITS dataset. Table 3.2 presents summary statistics of the key variables used in the regression analysis, while Table A12, in the appendix, provides a country list of the sample and years of conflict per country between the period 1960 and 2010.

In undertaking empirical analysis within the field of conflict and economic growth, data limitations are a problem. Countries that have experienced war are likely to have the worst data and even though data quality has improved, issues do remain. Some of the data issues relate to missing data (e.g. growth, education and investment) for periods where a country was in war (e.g. Angola and Sudan in the 1960's) and no data for countries such

with all datasets and something that now cannot be dealt with, only be acknowledged.

as Libya and Somalia, leaving a decreased sample of 36 countries. This, however, still represents a reasonable coverage of African countries and is consistent with other studies.

Table 3.2: Variable Description and Summary Statistics

Variable	Variable Description	Mean	Std. Dev
gdp	Real GDP per capita	1290	1605
invest	Investment as a share of GDP	16.62	10.69
edu	Percentage of secondary education attained in the population older than 25	11.93	12.64
pop	Population in 000's	11663	17810
conflict	Conflict indicator	0.17	0.37
intense	Intense conflict indicator	0.06	0.23
civil	Civil war indicator	0.13	0.33
Δgdp	Growth rate of real per capital GDP	0.010	0.070
$\Delta invest$	Growth rate of investment as share of GDP	0.014	0.250
Δedu	Growth rate of education attainment	0.053	0.052
$n + g + \delta$	Population growth rate + 0.05 used in Solow-style regressions	0.075	0.060

As Table 3.2 shows, for the 36 countries with available data, only 17% of all observations fall under episodes of conflict, which constitutes 29 of the 36 countries (81% of all countries in the sample have experience some form of armed conflict), with 76% being in the form of civil conflict and remainder recorded as interstate conflicts. Between 1960 and 2010, of all the observed conflicts, 35% were considered intense conflicts with annual battle deaths of over 1 000. Such widespread conflict (e.g. time and space) suggest why Africa has struggled to maintain any form of improvement in income, education and investment. Average income ($1290) and education attainment (11.9% of population over the age of 25) remains the lowest in the world, with average growth (1 and 5.3% respectively) equally dismal.

3.5 Empirical Results

Taking the specification in equation 3.4 and introducing dynamics gives the estimation equation:

$$\Delta \ln y_{i,t} = \alpha \ln y_{i,t-1} + \sum_{j=1}^{3} \beta_j \Delta \ln x_{j,i,t} + \sum_{k=1}^{2} \beta_k \ln x_{k,i,t-1} + \theta_1 (conf_{i,t})$$

$$+\theta_2 W_{pri}(conf_{pri,i,t}) + \theta_3 W_{\text{sec}}(conf_{\text{sec},i,t}) + \eta_t + \mu_i + \nu_{i,t} \qquad (3.6)$$

where y is GDP per capita, x_1 is investment as a share of GDP, x_2 is secondary educational attainment as a share of population over the age of 25 and x_3 is the population growth + 0.05 or $(n + g + \delta)$. The reparameterised first order dynamic model has all non-dummy variables in log form, with Δ representing the change in the dependent and explanatory variables. There is also a lagged dependent variable and lagged levels of physical and human capital. W_{pri} and W_{sec} are the contiguity matrices for primary and secondary neighbours, varying in the type of contiguity matrix (e.g geographical, political or economic similarities), which are interacted with neighbour respective conflict indicators to generate the spillover variables. Finally, η_t and μ_i capture are time and country fixed effects respectively, while $\nu_{i,t}$ is the error term.

The starting point for estimations is to regress the dynamic panel on the usual determinants of growth then add in conflict experience for the host country. These initial results, shown in Table 3.3, serve as benchmarks on which further variables are added to account for spillover effects. In Table 3.3 column 1, the results without host country conflict experience show investment and initial income to be of the expected sign and statistically significant, but, human capital is negative and significant. Population growth plus 0.05, which theoretically should have a negative impact on per capita GDP growth, is positive and statistically significant. This result for population growth, while opposite to theoretical predictions, is not uncommon

within the literature, particularly for low-income developing regions such as Africa or Asia and it certainly does not seem unreasonable in post-conflict economies (Grier and Tullock, 1989).

Table 3.3: Growth Effects of Conflict, Varying Over Conflict

	(1)	(2)	(3)	(4)
Conflict Type		Conflict	Intense	Civil
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\Delta \ln(inv)$	0.360**	0.036**	0.036**	0.036**
	(0.006)	(0.006)	(0.006)	(0.005)
$\Delta \ln(edu)$	-0.090**	-0.086**	-0.083**	-0.087**
	(0.031)	(0.031)	(0.031)	(0.031)
$\ln(n+g+\delta)$	0.093**	0.089**	0.091**	0.093**
	(0.012)	(0.012)	(0.012)	(0.012)
$\ln(y0)$	-0.024**	-0.026**	-0.025**	-0.024**
	(0.005)	(0.005)	(0.005)	(0.005)
$\ln(inv_{t-1})$	0.018**	0.018**	0.018**	0.018**
	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu_{t-1})$	-0.023**	-0.022**	-0.022**	-0.022**
	(0.004)	(0.004)	(0.004)	(0.004)
Conflict		-0.015**	-0.023**	-0.012*
		(0.005)	(0.007)	(0.005)
Year	0.001**	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.941**	-1.885**	-1.923**	-1.924**
	(0.540)	(0.539)	(0.538)	(0.539)
Observation	1765	1765	1765	1765
R-squared	0.096	0.102	0.101	0.100

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Similarly, the negative result for human capital is not unusual and Is-

lam (1995) attributes the irregular results to the discrepancy between the theoretical variable H (measuring quality) used in the model to the actual variable (measuring quantity) used in regressions. Likewise, the education variable in Murdoch and Sandler's papers and de Groot (2010) vary in sign and significance, indicating volatility in the variables performance. In the case of Africa and many other low-income countries, the true levels of human capital may not have increased much since 1960 and statistically, this leads to a negative temporal relationship between human capital and economic growth. Moreover, it is often the case that education attainment does not always translate into increased productivity and in many African countries the quality of education is a major concern.

To see if the choice of the human capital variable used in regressions matter, the Barro and Lee's education attainment variable was replaced by an index on the returns to human capital, found in Penn World Tables 8.0. This gave similar results, with human capital remaining negative and significant across all three conflict specifications.[10]

Violent conflict in the host country has a significant negative influence on economic growth and this is true for all three conflict types (columns 2 to 4). Not surprisingly, intense conflict (column 3), one which features more than 1 000 battle related deaths in a year, has the largest negative impact on growth, decreasing growth on average by 2.3 percentage points, while all conflicts and civil conflicts decrease growth by 1.5 and 1.2 percentage points respectively. The growth model results are impressively consistent across these specification changes and remains so with the introduction of the contiguity measures. For this reason, Table 3.4 only reports the coefficient estimates for the conflict and contiguity variables, using geographical distance, rather than the whole model. These are the best fitting models, in terms of R-squared, from a range of regressions run on conflict type (all types of conflict, intense and civil conflict) and different weighted contiguity matrices and considering both uni and multi-dimensional spillover effects.[11]

[10]See appendix Table A7 for estimation results varying in education attainment.

[11]The difference between the reported regressions and regressions with a lower R-squared

Uni-dimensional effects are observed only when primary or directly contiguous neighbours are involved, while multi-dimensional effects involve both primary and secondary neighbours. Specifications 1, 3 and 5 represent uni-dimensional spillovers, while 2, 4 and 6 are multi-dimensional. In all six specifications, conflict in a host country is estimated to have a negative and significant effect on host nation growth, with the spillover effects of conflict on neighbouring countries' growth rates differing. Although a host country conflict, irrespective of type, negatively affects primary neighbour growth, no such influence was found on secondary neighbours.[12]

Depending on conflict type and spillover dimensions, the results in Table 3.4 point to a host-country conflict having a negative growth impact on primary neighbours of between 1.2 to 2.0 percentage points. Interestingly, the coefficient sizes for primary neighbours are marginally smaller when multi-dimensional spillover effects are captured as compared to only uni-dimensional spillover effects. This may be indicative of a small "bounce back" effect primary neighbours experience from its contiguous neighbours (e.g. a host nations secondary neighbour).[13]

Interpreting the coefficients for neighbours is slightly different to that of the host nation, as the conflict coefficients in Table 3.3 measures an individual country effect while coefficients reported in 3.4 are measuring a neighbourhood effect. Since one has to take into account that each country has several neighbours, this means dividing the coefficients of $W_{pri}Conf_{pri}$ by the average number of neighbours. A host nation has on average 4.25 primary neighbours, translating to a per country influence of 0.235 ($\frac{1}{4.25}$), which implies that a host country conflict (column 2) will on average reduce a primary neighbour's growth by 0.28 (0.235*-0.012*100 = -0.28) percentage points. Depending on

was negligible, with all variables of the same sign and significance. Of the different contiguity matrices, border lengths for primary neighbours and minimum distance between nations for secondary neighbours provided the best fit.

[12]An interesting note is the coefficient for secondary neighbours in specification 6, Table 3.4. Although it is not significant the coefficient is larger and not characteristic of the results in general.

[13]All coefficient interpretations, henceforth, will be based on the multi-dimensional spillover specifications.

the types of conflict, this negative effect varies from 0.45 percentage points for intense conflicts to 0.35 for civil wars. The spillover effect from a conflict to primary neighbours is calculated to be roughly 20% ((0.28/1.4)*100) of the host country effect, with intense and civil wars approximately 20 and 29% of the host country effect, respectively.[14] These results are in line with Murdoch and Sandler's but differ from de Groot in finding no positive spillover effect on secondary neighbours.

Table 3.4: Growth Effects of Conflict with Geographical Contiguity Matrices

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict:	Conflict		Intense		Civil	
Weight:						
Pri	Border	Border	Border	Border	Border	Border
Sec		Dist		Dist		Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.015**	-0.014**	-0.023**	-0.023**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.013*	-0.012†	-0.020**	-0.019*	-0.016*	-0.015*
	(0.007)	(0.007)	(0.009)	(0.009)	(0.007)	(0.007)
$W_{sec}Conf_{sec}$		-0.008		-0.010		-0.017†
		(0.009)		(0.013)		(0.010)
Constant	-1.882**	-1.874**	-1.827**	-1.789**	-1.951**	-1.994**
	(0.538)	(0.538)	(0.540)	(0.542)	(0.539)	(0.539)
Observations	1765	1765	1765	1765	1765	1765
R-Squared	0.104	0.104	0.104	0.104	0.102	0.104

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

[14]Since coefficients for secondary neighbours are insignificant, no conversion to per country effects are needed.

To consider the more comprehensive definition of distance discussed above, new contiguity matrices are constructed by reweighting the geographic distance contiguity matrices with matrices that capture economic and political distances and the results for the variables of interest are presented in Table 3.5.

Specifications 1, 3 and 5 estimates spillovers using weights that contain a measure of democratic (a 21 point democratic variable) and geographic distance, while specifications 2, 4 and 6 use a measure of economic (average bilateral trade) and geographic distance. The results for conflict afflicted countries are identical to those in Table 3.3 and 3.4, with coefficients ranging between 1.2 and 2.3 percentage points across the specifications. Again, there seems to be no significant spillover effect of conflict on secondary neighbours. The coefficients for primary neighbour conflict, weighted first with democratic distance (columns 1, 3 and 5) and second with bilateral trade (columns 1, 3 and 5), are negative and significant, but smaller than the non-reweighted matrix results in Table 3.4. On average, the difference in coefficient sizes varies from the marginally lower 8% for all conflicts to as large as 16% for intense conflicts.[15] This is an interesting result, suggesting that studies which only use geographical distance could be overestimating the negative spillover effects of conflict.

Using political and economic distances measures means that the weights are reallocated in such a way that countries that may be close geographically are now "further away" and vice versa. Since the contiguity matrix remains a representation of distance, the reweighted matrices that include economic and political similarities are simply a more sophisticated distance measure giving weights reflecting a relative distance between countries. To get a better idea of what this means, consider the country case of Mali in 2007, which has seven primary neighbours, two of which were involved in conflicts (e.g. Algeria and Niger). Using only the geographic distance weighting, conflicts in Mali's primary neighbours is estimated to have a negative spillover

[15]This dissimilarity is calculated by taking the difference of the coefficients in Table 3.3 and 3.4, and divided by the coefficient in Table 3.3 (e.g. ((0.13-0.12)/0.13 = 0.077).

effect on Mali's economic growth of 0.36 percentage points. By adjusting the contiguity matrix to allow for political and economic similarities with neighbours, the spillover effect is reduced to 0.31 and 0.26 percentage points respectively, while a combination of the trade and polity weights would lower it to 0.28 percentage points. Estimates for the combined effect (political and economic distance) can be found in Table A8 in the appendix. This negative effect is expected to be between the weighted trade and polity coefficients since the combined effect is a normalised weight of the two separate matrices.

Table 3.5: Growth Effects of Conflict with Political, Economic and Geographical Contiguity Matrices

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict:	Conflict		Intense		Civil	
Weight:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.015**	-0.014**	-0.023**	-0.023**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.012*	-0.010*	-0.016*	-0.010†	-0.013*	-0.012*
	(0.006)	(0.005)	(0.008)	(0.006)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.005	-0.008	-0.017	-0.003	-0.014	-0.001
	(0.009)	(0.006)	(0.012)	(0.009)	(0.009)	(0.006)
Constant	-1.867**	-1.846**	-1.781**	-1.872**	-2.015**	-1.928**
	(0.538)	(0.538)	(0.541)	(0.540)	(0.539)	(0.539)
Observations	1765	1765	1765	1765	1765	1765
R-Squared	0.104	0.105	0.105	0.103	0.103	0.104

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Computing spillovers using only border distance, the weight of Algeria and Niger on Mali is 0.19 and 0.11 respectively. This combines to give a weight of 0.30, which translates to a conflict spillover of -0.36 (0.30*-0.012*100 = -0.36) percentage points, where the -0.012 is the coefficient of $W_{pri}Conf_{pri}$ from Column 2, Table 3.4. Similar exercises are done for the polity, trade and combination of polity and trade weights. For example, the polity spillover weight of Algeria and Niger on Mali is 0.22 and 0.04 respectively, giving a total weight of 0.26. This converts to a conflict spillover effect on growth of -0.31 percentage points.

For Mali, it seems that the main source of this spillover reduction when moving beyond the geographical distance measure is Niger, 0.04 using the polity weight, compared to 0.11 when using geographical weights. Although, relative to other primary neighbours, Niger shares a reasonably sized border with Mali (11 percent of Mali's total border distance), it is very different politically and trade between the two countries is of a minuscule amount. Thus, contiguity weights that only use geographical distance has the potential to hide complex relationships between countries such as that of politics and economics. Given the above, spillover effects using only geographical distance can be overstated since countries that were initially thought to be close are actually further away. While it is also possible that introducing the political and economic distance measures could increase the spillover estimates, it would appear that for these African countries, the estimated spillover effects of conflict are reduced. In fact, across all regressions, the average spillover effects using the new "hybrid" weights are lower than before.

A major concern with this type of analysis is whether the results are being driven by the particular choice of data, variables or estimation method. To evaluate the robustness of the results, the regressions are rerun using different data sets, removing outliers, replacing the dynamic panel approach with Murdoch and Sandler (2002b) and de Groot (2010)'s estimation method and substituting the conflict indicator with conflict duration. Using different datasets for population growth, investment, per capita GDP and education did not change the significance or sign of the results, while the main es-

timation results were unchanged when country outliers such as Botswana, Lesotho and Sudan are removed.[16] As Table A10 shows, changing the estimation method to that of Murdoch and Sandler and de Groot's led to a slight decrease in the significance of primary neighbour spillovers, but the estimate remains statistically significant and negative. In terms of spillover effects onto secondary neighbours, the estimation result remains negative and insignificant. Finally, replacing the conflict indicator variables with conflict duration led to changes in the results, (see Table A11 in Appendix) decreasing the significance of neighbour country spillover effects to the point where a host-country conflict has no regional spillover effects. But as in other studies, the conflict duration variable in this chapter is outperformed by the conflict dummy variable for all specifications suggesting that it is the mere presence and not the duration of conflict that matters.

3.6 Conclusion

Conflict can be a major barrier to development and yet despite a large literature on the determinants of conflict, there has been relatively little empirical analysis of its economic effects and even smaller literature dealing with the spillover effects it can have on neighbours. This chapter has added to the limited literature by providing an analysis on the spillover effects of conflict using a balanced panel of 36 African countries for the period 1960 to 2010. It provides results that show consistency with previous studies, in finding a negative effect of conflict on the host economy and negative spillover effects on neighbours. Using weighted matrices for the conflict variable based on distance measures and distinguishing between primary and secondary neighbours, suggests that primary neighbours are affected by conflict, but not secondary neighbours, an equivalent result to Murdoch and Sandler, but differing from de Groot.

Recognising that geographical distance may not be the only relevant fac-

[16]See Appendix Table A9 for estimation results.

tor and measure of distance when considering the proximity of neighbours, measures of distance that incorporate political and economic factors are introduced into the weighted matrices, giving a new determinant of distance. The result of this was to decrease the estimated negative spillover effect of conflict by a considerable amount and this estimate seemed robust to data and specification changes. This does not alter the finding that conflict can be devastating to both countries engaged in the fighting and their neighbours, but suggests that care is needed in judging the effects of conflict on neighbours, as only looking at geographical distance is not enough.

Finding results of significant primary country spillovers that are consistent with those of Murdoch and Sandler provides further and updated support for their assertion that aid providers need to consider supporting entire conflict regions and not just conflict burdened countries. The results also suggest that assistance should be focused on host countries and close neighbours, with less emphasis on secondary neighbours or conflict duration. Additionally, the definition of close should be determined by more than just geographical distance, but also political and economic distance. Finally, aid is potentially necessary in all conflicts and not, as de Groot (2010) suggests, simply in the case of most violent forms.

CHAPTER 4

The Determinants of Civil War and Excess Zeroes

4.1 Introduction

Civil war reverses development, it diverts resources from productive activities to destruction. It can be considered a double loss since there is the opportunity cost of these productive resources and loss from the damage that it inflicts (Collier et al., 2003). Just as measuring these conflict costs is of great importance, understanding the factors which make civil conflict more or less likely to occur is also an important developmental concern.

Violent internal conflict has ravaged many countries in the world. Since 1960, the average prevalence of civil war is about 12%, with a peak of 17% in the years 1990 and 1991 (Lacina and Gleditsch, 2005; Themner and Wallensteen, 2014). This led scholars to ask the question: why is there so much civil war in the world? To understand the forces behind the source of this human suffering, research to answer why civil wars occur has become a major focus. Following the seminal contributions of Collier and Hoeffler (2004)

and Fearon and Laitin (2003) empirical work on the causes of civil war has burgeoned, providing valuable insights into the role economic factors play in civil war initiation, continuation and potential end (Blattman and Miguel, 2010).

In empirical research almost all studies use some form of probit or logit model to estimate a zero-one dependent variable on a panel or cross-section of countries. There is, however, a potential that these models do not perform well in situations where there are a large number of zeroes in the dependent variable, a likely case for civil conflict as, fortunately many country-year observations are zero (e.g. peace). Until recently there has been little recognition of this issue, possibly because earlier models were estimated on cross section data, five year average panels or lacked the appropriate empirical tools, but the use of annual data in panels has made it an issue of greater concern. Using a probit or logit model in the presence of excess zeroes can potentially lead to biased estimates due to the correlation of the error term with the explanatory variables (Bagozzi et al., 2015).

In conflict studies the dependent variable normally takes a binary form, where the value one is recorded when the number of battle-related deaths exceeds a particular bound (e.g. 1000) and zero otherwise. This zero however, encompasses a situation when the number of battle related deaths is zero and there is complete peace and one where there are minor conflicts still present with the battle related deaths below the defined threshold. In addition, heterogeneity across countries means that a zero may represent a break between conflicts in a conflict ridden country or a year of peace in a completely peaceful country. Consider the difference between a zero for a country such as Sweden or Australia which has almost no chance of civil war, and a zero for countries like Democratic Republic of Congo (DRC) or Cambodia, where civil war risk is considerably higher. Thus, when coded uniformly, the zeroes from the different countries can come from two distinct processes and not taking this into account can lead to statistically biased estimates when evaluating the impact of explanatory variables on the dependent conflict variable.

Another issue relates to the choice of models. When the conflict dependent variable has excess peace observations or zeroes, probit and logit models cannot statistically account for the observable and latent factors that generate these high proportions of zeroes. The normal probit and logit models generate only one latent equation and are unable to account for or differentiate between the different additional weights put on zero observations, especially if the zeroes relate to different processes. Using probits or logits in hypothesis testing could lead to model misspecification (Harris and Zhao, 2007). A further concern is whether the probit or logit models conform to the process that generated the data. In the case of civil conflict, it can be characterised as an event of rare occurrence where research has suggested a Poisson distribution to better suit the data than logistical or normal distributions (Smith and Tasiran, 2012).

To get some idea of the likely effect of using normal logit or probit models, when a split population or zero-inflated model might be more suitable (see Bagozzi et al. (2015)), this chapter starts by applying a zero-inflated Poisson model to the data set of a published study by Elbadawi and Sambanis (2002) on the determinants of civil war prevalence, considering the impact on the results and its implications. Following from the data replication, the chapter then uses the zero-inflated Poisson to revisit the greed and grievance debate on an updated data set of 134 countries for the period 1960 to 2013. The next section gives a brief review of the determinants of civil war literature. This is followed by an overview of the zero-inflated Poisson (ZIP) model. Section four then provides the results of the replication analysis of Elbadawi and Sambanis (2002). Thereafter, section five presents the empirical re-estimation of the greed-grievance argument, applying the ZIP model to the new data set. The final section offers some conclusions, with discussion on the implications of future civil war research.

4.2 Evidence on the Causes of Civil Conflict and Excess Zeroes

Civil conflict, an increasingly numerous phenomenon, can be explained through concepts of motivation and feasibility. A distinction made obvious in the Collier and Hoeffler (2004)'s econometric model of civil war. Based on a rational choice model, rebellion and conflict might be motivated purely by greed, where income is achieved during the rebellion from looting or after a successful rebellion from control of state revenues. Alternatively, rebellion might be purely motivated by grievance, where there is either a genuine or perceived injustice that needs to be redressed. In this case, the probability of conflict increases as benefits rise relative to costs. These conflicts have most commonly been thought of as being caused by differences in religion, ethnicity, income and class. Yet, until recently none of these commonly held views have been the subject of empirical testing. Since then, a number of papers by the likes of Fearon and Laitin (2003), Collier and Hoeffler (2004) and Elbadawi and Sambanis (2002) have tackled these issues, turning statements of correlation into causal relationships.

Literature on trying to find these causal relationships of civil conflict have been dominated by cross-country regressions, with a consensus been developed on factors that make countries more prone to civil war. They are considered more likely to occur in countries that are poor, have low growth rates, are easily subjected to adverse income shocks and have high dependence on primary commodity exports (Blattman and Miguel, 2010). These causal relationships depicted by income, commonly grouped as "greed" variables, are interpreted as lack of opportunities which make rebel recruitment and participation easier (Collier and Hoeffler, 2004). The opportunity cost for rebels is considered lower for countries with low growth and income, while chances of gain from war is much higher. Countries with high proportion of primary commodity exports in their GDP are thought to be more prone to conflict due to natural resources acting as a source of finance for rebellion and weakening institutions (Humphreys, 2005; Robinson et al., 2006).

Early studies by Fearon and Laitin (2003) and Collier and Hoeffler (2004) argue that these economic incentives are decisive in predicting civil war, but political grievance have little explanatory power. An assertion that has been backed up by the likes of Hegre et al. (2001), Montalvo and Reynal-Querol (2005), Ross (2006), Besley and Persson (2014) and Hoeffler (2012). Despite the theoretical links between grievance and civil war, various authors find variables proxying for factors such as political rights, income inequality, ethnicity and religion to add little explanatory power to civil conflict. So far most of the discussion on the determinants of civil war has focused on civil war onset or incidence, but there has also been work on the prevalence of civil war (Elbadawi and Sambanis, 2002; Reynal-Querol, 2002; Besley and Persson, 2010). Although studies on civil war incidence consider the start of wars and analysis of its prevalence assess start and continuation, they share common empirical results.[1] Irrespective of whether studies consider civil war prevalence or incidence, economic factors are estimated to better predict an occurrence of civil war than factors relating to grievance.

Following these initial contributions, the literature on the determinants of civil war has seen many diversifications with research moving in the direction of improving causal identification, measurement and conflict definition. Although there is a general consensus linking civil conflict to low levels of income and negative income shocks, the direction of the causation is contested. To address this endogeneity concern, scholars have tried lagging the explanatory variables, but the most success has come from the use of exogenous variation in rainfall as an instrumental variable for income growth (Miguel et al., 2004). By instrumenting income growth with rainfall growth, Miguel et al. (2004) find a 5% drop in income growth leads to an increase in civil conflict likelihood in the following year by almost 10%. A result that has since been supported among 60 quantitative studies, where warmer temperatures or extremes in rainfall is causally associated with changes in civil

[1]Prevalence can be defined as the likelihood of observing a civil war at any point in time $Y(t)$, estimating the probability of that $Y(t) = 1$ is the sum of the probability that war occurs at time t contingent on there being no war at $t-1$ and the probability that war occurs at time t given that war had been ongoing at time $t-1$.

war (Hsiang et al., 2013).

With the literature moving towards finding better causal identification, other scholars have looked to illustrate the importance of better measurement. For instance, Ross (2006) argue that compared to older natural resource measures, improved measures of oil and diamond deposits are strongly associated with more civil conflict. Likewise, the lack of significance of the objective grievance variables has been strongly contested by political scientists. Most recently by Buhaug et al. (2014), who suggests that the lack of significance had to do with the poorly measure proxy variables (e.g. Gini coefficient and ethno-linguistic fractionalisation) used in previous research. By using variables that better reflect ethnic and income inequality, the authors find that political and economic grievances do matter.

As the civil conflict literature advances to deal with issues arising from the original contributions, some empirical questions do remain. There is currently little agreement on the correct econometric specification, authors vary in the use to annual versus five-year periods, the definition of civil conflict, the appropriate estimator for these rare events and the degree of measurement error in the dependent and independent variables (Blattman and Miguel, 2010). Sambanis (2004) found major differences in the datasets used by various authors, with most attributed to the different definitions of civil war, while others such as Vance and Ritter (2014) and Smith and Tasiran (2012) have questioned the estimators used to study these rare events. Interestingly, looking back at the literature, one sees that almost all empirical research on civil war has used some form of probit or logit model to estimate a set of explanatory variables on a zero-one dependent variable. Yet recent analysis have suggested that research using these models can potentially run into econometric challenges due to two important issues.

Firstly, the use of a zero-one indicator variable to denote conflict or peace often runs into the problem of excess number of zero observations (e.g. peace observations) These zeroes, often in the region of 80% of total observations, have the potential to be heterogeneous and come from different data generating processes. In this case, estimates that use the common probit or

logit models to determine civil war risk may run into issues of model misspecification and biased estimates (Bagozzi et al., 2015). To navigate this issue, Bagozzi et al. (2015) suggest that an alternative method, specifically a split-population or zero-inflated model, should be used to address excess zeroes in the dependent conflict variable. Using this method, they find that when the dependent variable contains excess zeroes, estimates which use zero-inflated or split population models are more reliable and consistent compared to those from ordinary probit or logit models. Furthermore, they indicate zero-inflated models produce more accurate coefficient estimates of key independent variables on conflict outcome.

The second issue on an appropriate estimator follows from concerns of whether probit or logit models used in the estimation of civil war risk conforms to the process that generates the data (Smith and Tasiran, 2012). Richardson (1960) initially found civil wars starting per year to closely fit the theoretical Poisson distribution of rare events, a result confirmed by Wilkinson (1980) and Benoit (1996). It would seem that in the case of civil war, an event count process that is characterised by having a rare occurrence, a Poisson distribution is likely to better suit the data than logistical or normal distributions. By combining Bagozzi et al. (2015) use of split-population models with the suggestion of a Poisson distribution to better fit the data, a zero-inflated Poisson model is tested as the preferred empirical model.

While research on civil wars have "mushroomed" to numerous avenues, this chapter looks to revisit the origin of the determinants of civil war, retracing back to the initial greed versus grievance argument and addressing the main concern of appropriate estimators, with emphasis on conflict definition and better variable measurement. If using a more appropriate estimator for rare events do matter, then the existing analyses on civil war risk, with greed variables commonly thought to outweigh grievance terms, may be called into question. These studies may be prone to estimation bias as not all zeroes represent true peace, and thus it becomes difficult to pinpoint the true underlying causes of civil conflict.

4.3 Modelling Zero-Inflation in Civil Conflict

In most analyses on the determinants of civil conflict, an ordered dependent variable is used in which a given country-year is assigned a zero for peace and a value of one when violence between the state another side reaches a given threshold, classifying it as a civil war. This would generally mean that there are a large number of zero observations as peaceful years will dominate conflict years. These zeros can be considered as reflecting rather different states, one where the structural and societal forces ensure a zero probability of civil conflict regardless of greed or grievance incentives and another that reflects a break in fighting and a high probability of returning to conflict.

The first group of zeros will often be advanced or welfare economies, such as Norway, Sweden, or Japan and can be labelled "complete-peace" while the second group, are often found in developing regions such as sub-Saharan Africa, Asia or Latin America, from which the zeroes can be labelled as "incomplete-peace". The main difference between the first and second type of zero is that while the probability of transition into war for first type is zero, the probability for the "incomplete-peace" group is not. In the case of a "incomplete-peace" incentives resulting from opportunity or grievance can induce violent conflict. There is also a third type of zero observation where there is still fighting taking place, but the violence has not reached the 1 000 battle related deaths threshold that is used to define a civil war. Such cases can be labelled as "incomplete-war". Given the high proportion of heterogeneous zeroes in the analysis, using ordinary probit or logit models may not be an appropriate tool for statistical inference and can potentially give biased estimates (Bagozzi et al., 2015).

To shed some light on the above mentioned types of zeroes, the world map in figure 4.1 below provides a breakdown of countries that are categorised as "complete peace" (white), "incomplete-peace" (light grey) and "incomplete-war".[2] Interpretation of the illustrated map is intuitive, countries in the least

[2]Countries highlighted in white are those that have never experienced a civil conflict and thus labelled as "complete peace" . Those coloured in light grey are countries that have

developed regions of the world, such as Africa, South-east and Central Asia are often found to be in the category of "incomplete-peace"or "incomplete-war". By contrast, highly developed countries and democracies, such as those found in Europe, North America and parts of Oceania almost always belong to the "complete peace" group.

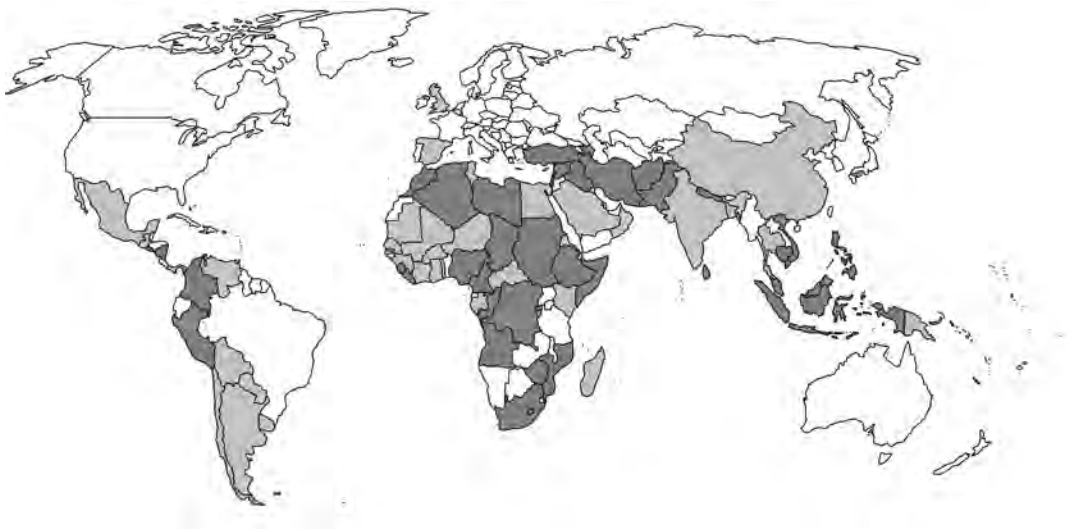

Figure 4.1: Complete peace, incomplete peace and civil war intensity

With evidence of the large amounts of heterogeneous zeroes, a more satisfactory estimation alternative is to use a split population or two-part model as proposed by Harris and Zhao (2007) and Vance and Ritter (2014). This is typically in the form of a zero-inflated models, or in this case a zero-inflated Poisson model, where estimations follow two stages. The first of the two latent equations, stage one, is a selection equation, while the second stage is a Poisson outcome equation. This splits the observations into two processes, each potentially having different sets of explanatory variables. In the context of civil war prevalence, zero observations in process 0 ($w_i = 0$) include inflated zeroes that never experience civil conflict (e.g. Sweden), while zero

experienced some form of minor civil violence (e.g. between 25 and 999 battle related deaths in a given year) over the past 54 years and can be considered as "incomplete-peace" and "incomplete-war" . Countries in dark grey are those that have had intense civil conflicts totalling over 1 000 battle related deaths in a year and can be considered as a truly conflict group.

observations in process 1 ($w_i = 1$) includes cases for which the probability of transitioning into a civil conflict is not zero and civil war casualties have not reached the lower bound (or limit) of 1 000 battle related deaths. The binary variable w indicates the split between process 0 (with $w_i = 0$ for no war) and process 1 (with $w_i = 1$ for war). w is related to the latent dependent variable w_i^* so that $w_i = 1$ for $w_i^* > 0$ and $w_i = 0$ for $w_i^* \leq 0$, where w_i^* now represents the propensity to enter process 1 and is given by the split probit (1st stage) equation:

$$w_i^* = x_i\gamma + \mu_i \tag{4.1}$$

where x_i is a vector of covariates, γ is its coefficients and μ_i is the error term. The probability of i falling into process 1 is $\Pr(w_i = 1|x_i) = \Pr(w_i^* > 0|x_i) = \Psi(x_i g)$, and the probability that it is in process 0 is $\Pr(w_i = 0|x_i) = \Pr(w_i^* <= 0|x_i) = 1 - \Psi(x_i\gamma)$, where $\Psi(.)$ is the standard normal cumulative distribution function. For the Poisson outcome equation, the propensity for participation in which the response variable Y_i (i.e conflict) has a distribution given by:

$$\Pr(Y_i = y_i) = \begin{cases} w_i + (1 - w_i)^{e^{(-\lambda_i)}} & , y_i = 0 \\ (1 - w_i)^{e^{(-\lambda_i)}} \frac{\lambda_i^{y_i}}{y!_i} & , y_i > 0 \end{cases} \tag{4.2}$$

where the parameters λ_i and w_i depend on vectors of covariates x_i and z_i, respectively, which are modelled as:

$$\log(\lambda_i) = x_i^t\beta \tag{4.3}$$

and

$$\log(\frac{w_i}{1 - w_i}) = z_i^t\gamma \tag{4.4}$$

with mean and variance as $E(Y_i) = (1-w_i)\lambda_i$ and $var(Y_i) = \mu + \left(\frac{w_i}{1-w_i}\right)\mu^2$. In this ZIP model, the matrices z and x contain different sets of experimental factor and covariate effects that relate to the probability of the "zero-state"(zero probability of civil war) and the Poisson mean in the "nonzero-state"(probable civil war), respectively. Thus, the γ's have interpretations in terms of the factor level effect on the probability that there is a zero probability of conflict and the β's have the interpretation of the effect on the average risk of civil war when the probability is non-zero. Following Lambert (1992) the ZIP model (equation 4.2) can be regressed using maximum likelihood with an Expectation-maximum (EM) algorithm.[3]

While empirical research on the determinants of civil conflict has generally followed a more standard approach of assuming normality, conflict data is produced in a discrete and countable manner and the number of events can also never be negative or a non-integer. This does not suggest a normal or logistical distribution and the error terms in a regression would not be normally distributed and the observed variables would not be a linear function of the covariates (Benoit, 1996). When civil conflict is a random event, and is observed at the end of each observation period i (common in conflict studies), then the data will conform to a Poisson process which has a rate of occurrence λ, where $\lambda > 0$, as long as the zero events occurred at the start of the period and no more than one event occurs at the same time. Both these assumptions are satisfied in civil war research, as firstly, by definition, no more than one civil war can occur in a given country. Secondly, since conflicts are only recognised if the threshold (either more than 25 or 1000 battle-related deaths in a given year) has been reached at the end of a calendar year, occurrences in the previous period are considered independent events. In other words, conflict events that occur must be both *stationary* and *independent*. Additionally, Benoit (1996) stated the possibility of over-dispersion in the Poisson estimates and suggested using negative binomial as an alternative. This does not seem to be the case here as the variance and mean in the data sets are not statistically different from each other and

[3]For full derivation of the model see Lambert (1992) and Hall (2000).

insignificant log-likelihood ratio tests for alpha=0 rejects the notion that a zero-inflated negative binomial is preferred to the zero-inflated probit model. Thus, the Poisson distribution used in this chapter seems theoretically more suitable than the normal or logistical distributions and has been shown to fit the distribution of conflicts over time.

The use of ZIP model allows more accurate estimates to be obtained compared to using standard probit or logit models, as the probability of a zero observation is now modelled conditional on the probability of zero from the Poisson process plus the probability of being in process 0 from the splitting equation. It should be noted that the usefulness of the model (i.e. unbiased estimates) declines when the size of the split in the sample population becomes very big or very small and can lead to biased results, with statistical inference increasingly difficult as the proportional of zeroes gets closer to one. Bagozzi et al. (2015) suggests that this will become an issue when there is less than 10 percent or greater than 90 percent of zero observations.

4.4 An Empirical Investigation

Elbadawi and Sambanis (2002) provide an influential contribution to the "greed-grievance" debate by combining Collier and Hoeffler (2004) model of civil war onset with Collier et al. (2004) model of civil war duration. Their model predicts the prevalence of civil conflict, based on opportunities for rebellion against its constraints. These opportunities are divided into greed versus grievance or rebellions that generate profit versus rebellions triggered by genuine grievance. They code incidents as civil conflicts using five categories, (1) the war caused more than 1 000 battle-related deaths, (2) it challenged the sovereignty of an internationally recognised state, (3) it occurred in the territory of the state, (4) it included the state as a principle combatant, and (5) the rebels were able to mount a organised military opposition to the state. Their sample includes over 150 countries between the

period 1960 to 1999, with a dependent variable having about 81 percent of zero or peace observations. Using a probit model, Elbadawi and Sambanis find that prevalence of civil war is consistent with earlier studies on war onset and duration (Table 4.1, column 1). It is positively influenced by primary commodity exports as a share of GDP (a proxy for "looting" or economic opportunity), population and previous wars experiences in the past 10 years, while the level of GDP, the growth of per capita GDP and squared term of primary commodity exports as a share of GDP have negative effects. As with most studies in the literature, grievance factors such as ethnic fractionalisation, ethnic dominance and polity (proxy for political rights) were statistically insignificant.

Given the potential for high proportion of heterogeneous zeroes, which can be thought of as including "complete-peace" or "incomplete peace" , the use of a simple probit can be questioned and a zero-inflated Poisson model (ZIP) would seem more suitable. To evaluate these claims, this chapter first estimates the main Elbadawi and Sambanis (2002) specification using a normal probit. This is followed by estimations using the ZIP model for the Elbadawi and Sambanis data. The results for both are presented in Table 4.1. The first set of results (1) provide the standard probit model and the next two columns (2) give the ZIP results, the first stage estimates (Outcome) and the second stage (Inflation) estimates. In order to remain consistent with Elbadawi and Sambanis, covariates in the outcome equation of the ZIP model are identical to the normal probit. Moreover, in identifying plausible indicators for conflict "relevance", variables that are included in the inflation equation should directly influence the probability that a country in any given year always experiences peace (i.e. per capita GDP, ethnic diversity or political freedom).

The results reveal that in the case of the ZIP inflation equation, real GDP has a positive and significant effect on the likelihood that a country-year to be among the always zero or "complete peace" group. Thus, the higher a country's real GDP, the greater chance of it being always peaceful. In numerical terms, if a country increases its real GDP by 1%, the likelihood of

the country being in the "complete peace" group would increase by a factor of 1.001 (e.g. exp(0.0018)). Interestingly, primary commodity exports as a share of GDP has no significant effect on the odds of always being zero. Assessing the grievance variables reveals some more valuable insight on the differences between the two types of zeroes or peace observations. Ethnolinguistic diversity now has an impact on the likelihood of being completely peaceful. This relationship is estimated to be parabolic, first decreasing and then increasing.

In the context of the inflation equation, the coefficients represent the factor change in the probability of being completely peaceful compared to incomplete peace. It is interesting to note that when the same variables are included in both the outcome and inflation equations, the signs of the corresponding coefficients from the binary equation are often in the opposite direction to coefficients in the outcome equation. This makes substantive sense since the process in the inflation equation is predicting membership in the group that is always peaceful, while the outcome equation predicts conflict risk conditional on a country being able to experience a civil conflict.

Table 4.1: Probit and ZIP of Civil War Prevalence 1960-1999

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
Pri Exports/GDP	10.53*	9.488*	-2.276
	(4.136)	(4.341)	(5.061)
Pri Exports/GDP^2	-21.24*	-23.41*	
	(9.325)	(11.31)	
log real GDP	-0.0003**	-0.0004**	0.0018*
	(0.000)	(0.000)	(0.0009)
RGDPPC Growth	-0.0899**	-0.122**	
	(0.0286)	(0.034)	
Polity Index (1 lag)	-0.0115	0.0135	

Continued on next page

Table 4.1 – *Continued from previous page*

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
	(0.020)	(0.0184)	
Polity Index^2 (1 lag)	0.0032	0.0035	
	(0.0041)	(0.0042)	
Ethno Diversity	0.0389	0.0656**	-0.231**
	(0.0258)	(0.0178)	(0.0759)
Ethno Diversity^2	-0.0004	-0.0007**	0.0024**
	(0.0003)	(0.0002)	(0.0008)
Log Population	0.599**	0.266*	-2.532**
	(0.140)	(0.107)	(0.946)
Constant	-12.48**	-6.805**	
	(2.569)	(1.962)	
Rho	0.601**	-	
	(0.086)	-	
Observations	783	783	
Zero Observations	-	692	
Log likelihood	-189.771	-223.663	
Wald χ^2	33.11	-	
Vuong test	-	3.41	
AIC	479.33	401.54	

Notes: AIC = Akaike Information Criterion; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Comparing the estimations on civil war prevalence, the probit and ZIP estimates for the outcome equation (1) and (2) show similar coefficients for most of the variables, but also a striking difference. Starting with the opportunity variables, primary commodity exports as a share of GDP is highly significant and has a non-linear effect in predicting the probability of civil

conflict. Income, both in GDP levels and growth in per capita GDP, are negative and significantly related to civil war risk. These are consistent with previous findings within the literature and can be thought of as both economic incentives and costs of participation. While the zero-inflated Poisson estimates of opportunity variables are consistent with the normal probit, intriguing differences emerge in the grievance variable estimates. Ethnolinguistic diversity is now statistically significant, having a non-linear effect of first increasing and then decreasing the risk of civil war prevalence.

A Vuong (1989) test and Akaike Information Criterion (AIC) are run, both favouring the zero-inflated Poisson model over the traditional probit estimator. As a robustness check across the different specifications used by Elbadawi and Sambanis, ethnic diversity is replaced with ethnic dominance (See Table A13 in Appendix), revealing the same consistent results with the additional polity index also becoming significant. All the coefficients in the ZIP model, except log population and primary commodity exports as a share of GDP have larger coefficients than in the standard probit, possibly suggesting that not allowing for zero-inflation leads to civil war risk being underestimated.

Empirical estimations using the Elbadawi and Sambanis (2002) data provide a strong case for arguing that the determinants of conflict literature should consider moving from standard probit and logit models to some form of a zero-inflated model. If not, researchers risk both underestimating the risk of civil conflict and making erroneous conclusions regarding its significance. Having established that the zero-inflated models yields potentially better results for civil conflict prevalence, the next section develops the analysis by estimating a more general greed-grievance model based upon the literature and using data for the period 1960 to 2013.

4.5 Greed vs. Grievance Revisited

To provide the opportunity to specify a general greed grievance empirical model, a range of variables were collected based upon the debates in the literature. Proxies for greed or opportunity include real GDP, growth in GDP per capita, degree of urbanisation, life expectancy and natural resource dependence. For this study two sets of income variables were collected, from the World Bank and Penn World Tables 8.0. Degree of urbanisation is measured as the proportion of a country's population living in an urban environment, while life expectancy follows the usual measurement.[4] Male secondary school enrolment was not used in the estimations due to poor and incomplete data. Following from the literature, natural resource dependence is measured by the share of primary commodity exports in GDP. The World Bank provides data for the period 1960 to 1999, which was cross referenced with Fearon (2005) for consistency. The remaining 14 years are constructed using export data (primary commodities) provided by the World Trade Organisation (WTO) and GDP from the World Bank.

Taking into consideration the numerous debates on the measure of natural resource dependence and the type of commodities used, three additional measurements are considered. A measure of oil production in metric tons and oil exports greater than one-third of total exports are used to proxy for oil abundance and dependence respectively.[5] To distinguish between fuel and non-fuel minerals with other primary commodities, a mineral dependence variable was created. A country is considered mineral dependent if its mineral exports constitutes 25% or more of a country's total tangible exports. Percentage of mountainous terrain in a given country is included as

[4]This data is sourced from the World Bank, the degree of urbanisation can also be thought of as a measurement of geographic dispersion, the greater the urbanisation, the lower the geographic dispersion. All income figures are purchasing power parity (PPP) adjusted.

[5]Oil production in metric tons is provided by Ross (2013), this data goes from 1932 to 2011, the additional two years were drawn from the same source as the author, US energy information administration website for international energy statistics: http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm.

an indicator of military accessibility or safe havens for rebels

The grievance variables are, for the most part, common to those identified by Collier and Hoeffler (2004) and Fearon and Laitin (2003). This chapter considers three general measures of grievance: ethnic and religious hatred, political repression or freedom, and income inequality (horizontal inequality). Ethnic fractionalisation is the most commonly chosen indicator to test the linkage between ethnicity and civil conflict.[6] Measurements of ethnic fractionalisation is borrowed from Collier and Hoeffler (2004), with ethnic dominance used as alternative to ethnic hatred, which is measured as a binary variable taking on the value one if the largest ethnic group in a country consists between 45% - 90% of the population. To measure religious hatred, Collier and Hoeffler constructed a fractionalisation index analogous to ethnic fractionalisation and this is in turn used in the estimation process.

Other things being equal, political democracy or freedom should be associated with less discrimination, repression and civil war. Data from the Polity IV database is used to measure political rights, with the variable *polity* ranging from -10 (high autocracy) to 10 (high democracy). The relationship between political freedom and civil war has often been thought of having a non-linear effect (Hegre et al., 2001). This hypothesis is tested through the inclusion of *polity* squared term. In a recent paper by Buhaug et al. (2014), the authors found that new grievance indices of horizontal income inequality and political discrimination to perform much better than conventional indicators. They argue that economic grievance is captured by the relative gap between the mean national income and the income level of the poorest and richest groups (positive and negative horizontal inequality), while ethno-political grievance is measured by demographic size of the largest discriminated ethnic group.[7] This chapter uses these alternative variables as substitutes in robustness checks for ethno-political and economic grievance.

[6]Initially used by Easterly and Levine (1997), the fractionalisation index follows in accordance with Herfindahl's formula, and is interpreted as the probability that two randomly selected individual in a population belong to different ethnic groups.

[7]For full description and derivation of the variables see Buhaug et al. (2014)

The control variables included in the model are the standard ones found in the literature. Population, cold war and Africa feature in various specifications with their effects on civil war prevalence, apart from population, subject to much empirical debate. Finally, the dependent variable used here takes on a value of 0 for all peace year observations and a 1 for civil war years. For all the observations in the sample, 15% are classified as civil war, of which 11% had annual combat deaths ranging between 25-999 and 4% was above 1000.

Table 4.2: Descriptive Statistics - Means

	Full Sample	Not Always 0	Always 0	Civil war	No Civil war
Opportunity					
Primary Commodity Exports/GDP	0.156	0.178	0.139	0.109	0.164
GDP per cap	7931	14069	3311	3172	8699
GDP per cap growth	0.018	0.022	0.016	0.010	0.019
Mountains %	16.38	14.93	18.11	23.16	15.33
Rate of Urbanisation	46.94	56.00	39.73	40.61	47.92
Life Expectancy	61.61	66.15	57.98	59.41	61.95
Oil Production (Metric Tons 000's)	17000	13700	19300	19100	16700
Mineral Dependence	0.493	0.415	0.545	0.550	0.484
Oil Exports	0.187	0.155	0.208	0.168	0.189
Grievance					
Ethnic Frac (C&H)	63.02	52.06	69.85	77.47	60.05
Ethnic Dominance	0.470	0.483	0.467	0.549	0.457
Religious Frac (0-100)	36.47	36.07	36.58	0.36	0.37
Polity IV (-10 to 10)	1.13	3.84	-0.73	0.97	1.30
LDG	0.056	0.024	0.081	0.142	0.042
NHI	1.189	1.064	1.278	1.398	1.155
PHI	1.201	1.086	1.287	1.224	1.197

Table 4.2 presents the descriptive statistics of the above mentioned variables with a breakdown by conflict experience and always zeroes. These results seem to support the central thesis that the different zeroes in the sample are formed through completely separate processes. For the always zero or "complete peace" group, GDP per capita, per capita GDP growth, rate of urbanisation, life expectancy and political freedom are all higher than the non-always zero group. Moreover, countries which are potentially completely peaceful all have lower levels of ethnic and religious fractionalisation and income inequality.[8] Estimated correlations suggest some association between income and inequality variables and the likelihood of a country being completely peaceful versus incompletely peaceful. In episodes of civil conflict, GDP per capita, its growth, rate of urbanisation, life expectancy and political freedom are all lower compared to times of peace. Similarly, ethnic divisions, income inequality and substantial amounts of rough terrain are higher in cases of civil war. Interestingly, primary commodity exports as a share of GDP is on average lower in episodes of civil war compared to no civil war.

Estimating the probability of civil conflict using ordinary probit regression, with the civil conflict dependent variable taking the value of one if deaths total over 25 in a given battle or over 1000 in a given year and zero otherwise, gave the results in Table 4.3. The standard probit results (1) show GDP and per capita GDP growth to be highly significant in decreasing the probability of civil conflict, with primary commodity exports as a share of GDP also highly significant and non-linear. Primary commodity exports are seen to initially decrease civil war risk, reaching a trough when it constitutes about 33% of GDP, thereafter increasing civil war risk.[9] This is a peculiar finding which is considered opposite to the past literature. However, in light of the summary statistics in Table 2, where primary commodity exports as

[8]ldg = largest discriminated ethnic group, phi = positive horizontal inequality (relative gap between mean national income and income level of the richest group), nhi = negative horizontal inequality (relative gap between mean national income and income level of the poorest group)

[9]Differentiate the probability of civil war with respect to primary commodity exports (4.197/2(*6.436)) = 0.326

a share of GDP is lower for countries not in conflict, the result makes some empirical sense. Turning to the objective grievance terms only the Polity IV index squared is significant with none of the measures for ethnic and religious diversity and (Collier and Hoeffler (2004)'s definition) having any explanatory power. As for the control variables, population has a positive and significant effect on civil war prevalence while the Cold War dummy is negative and statistically insignificant. The likelihood ratio test of the correlation coefficient (*rho*) suggests panel estimator to be preferred to a pooled estimator. To see if a zero-inflated model would fare better in the context of excess zeroes observations, the same specification is ran using a zero-inflated Poisson model.

Table 4.3: Probit and ZIP Regression of Civil War Prevalence 1960-2013

	(1)	(2)		(3)	
	Probit	ZIP		ZIP	
	Outcome	Outcome	Inflation	Outcome	Inflation
Opportunity					
log RGDP	-0.129*	-0.988**	2.551**	-0.962**	1.129**
	(0.063)	(0.032)	(0.386)	(0.038)	(0.110)
RGDPPC Growth	-2.396**	-2.697**	9.793†	-2.242**	2.392*
	(0.506)	(0.432)	(5.412)	(0.473)	(1.059)
Pri Exports/GDP	-4.145**	-5.243**		-2.842**	10.377**
	(1.107)	(0.747)		(0.819)	(2.231)
Pri Exports/GDP^2	6.593**	7.324**		3.177*	-19.618**
	(1.571)	(1.240)		(1.257)	(3.420)
log % Mountains	0.020	0.057*		0.060†	0.077
	(0.094)	(0.025)		(0.025)	(0.072)
Grievance					
Polity Index	0.004	0.017**	-0.534*	0.051*	-0.270**
	(0.007)	(0.006)	(0.218)	(0.026)	(0.074)
Polity Index^2	-0.010**	-0.009**	0.070*	-0.013**	0.003

Continued on next page

Table 4.3 – *Continued from previous page*

	(1)	(2)		(3)	
	Probit	ZIP		ZIP	
	Outcome	Outcome	Inflation	Outcome	Inflation
	(0.001)	(0.001)	(0.029)	(0.004)	(0.008)
Eth Frac (C&H)	0.032	0.011†	-0.043**	0.014†	-0.084**
	(0.024)	(0.006)	(0.005)	(0.008)	(0.014)
Eth Frac^2(C&H)	-0.001	-0.001**		-0.001†	0.003**
	(0.001)	(0.000)		(0.000)	(0.001)
Ethnic Dominance	0.326	0.298**	-0.255	0.357**	-0.123
	(0.414)	(0.098)	(0.283)	(0.111)	(0.233)
Religious Frac	-0.272	-0.193		1.085**	-3.393
	(0.682)	(0.171)		(0.239)	(2.183)
Controls					
log Population	0.498**	0.112**	-3.080**	0.246**	-0.998**
	(0.125)	(0.02)	(0.444)	(0.055)	(0.131)
Cold War	0.084	0.083		0.220**	0.711**
	(0.082)	(0.067)		(0.075)	(0.191)
Constant	7.099**	-2.979**	9.950**	-6.086**	-11.339**
	(1.699)	(0.513)	(4.093)	(0.651)	(1.287)
Observations	4286	4286		4286	
Zero Observations	-	3382		3382	
Log likelihood	-1314.14	-2358.58		-2343.27	
Wald χ^2	159.34	-		-	
Vuong test	-	7.70		8.33	
AIC	4910.51	4761.18		4742.53	

Notes: AIC = Akaike Information Criterion; Dependent variable: Conflict prevalence; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Starting with the inflation equation, the variables of real GDP, per capita GDP growth, political freedom and ethnic diversity all represent plausible indicators that influence the probability that a country always experiences peace. To this end, the inflation equation (2) confirms that higher income and political freedom does indeed lead to greater probability of being in the "complete peace" group, while ethnic fractionalisation, ethnic dominance and population all have a negative effect. The variation in sign between the outcome and inflation estimates makes sense as one equation calculates the likelihood of countries being in conflict and the other on the probability of being in the completely peaceful group.

Moving onto the outcome equation, the zero-inflated Poisson model (2) gives signs that are consistent with the standard probit, but there are substantial differences in the significance of the grievance terms. Primary commodity exports as a proportion of GDP shows the same effect as the probit model, albeit at a higher turning point of 36% while income, both its level and growth, decrease the likelihood that a country experiences civil conflict conditional on that country being able to experience a conflict. Proxies for ethno-political grievance are better represented using the zero-inflated models than the standard probit model, with political freedom and ethnolinguistic diversity now significant predictors of civil war prevalence. Both of these variables feature in an inverse u-shape of first increasing and then decreasing civil war risk. A captivating finding is that using the ZIP model, percentage of mountains terrain, a proxy for geographic dispersion which inhibits government or military capacity, and ethnic dominance became positive and statistically significant in explaining civil war prevalence.

In addition to having more explanatory power and significance in the grievance variables, the ZIP estimates are shown to have lower standard errors and higher log likelihood values than the normal probit, which suggests a more accurate estimation outcome. The usual Vuong test and AIC are run, both rejecting the probit model and favouring the zero-inflated Poisson. As suggested in Cameron and Trivedi (2010), all regressions are estimated using robust standard errors, while the proportion of zero observations in the

sample (78.9%) falls within the accepted band of 10 to 90% (Bagozzi et al., 2015).

Ensuring that the zero-inflated Poisson estimates are not driven by the decision to include on specific variables relating to peace (e.g. income, political freedom etc.) in the inflation equation, a full model in which all the covariates in the outcome equation is included in the inflation equation. The results shown in (3) are consistent with the selective estimations found in (2). The selective variables in the inflation equation are ones commonly thought to have a direct impact on the probability of peace. Here comparison of (2) and the full model seen in (3) is a test for researchers degrees of freedom, whereby a researcher could selectively choose specifications in order to generate significant results or false-positives (Simmons et al., 2011). Similar results in (2) and (3) suggest the model is well specified, consistent to various specifications and not sensitive to researcher's degrees of freedom.

To consider the robustness of the results, a number of alternative specifications are considered. Table 4.4 is one example, with horizontal income inequality and ethnic discrimination added in place of ethnic dominance and religious fractionalisation, which increased the number of observations by over one hundred.[10] These results remain consistent with earlier estimates, where the zero-inflated Poisson model is preferred to the probit model in almost all instances. Intriguingly, after changing the specification, the Cold War variable is now negative and statistically significant, providing support to Blattman and Miguel's (2010) assertion that then number of civil wars have declined after 1990.

Adding variables on income inequality provides a new dynamic to the civil war prevalence process. Estimating the probability of being completely peaceful, the results from the inflation equation suggest that high income inequality between the poorest group and the country average decreases the probability of peace, while increases in income inequality between the richest group and the country level increases peace likelihood. Together, the two

[10]see Buhaug et al. (2014) for description of the income inequality and ethnic discrimination variables.

horizontal income inequality measures offer some insight into the process of a country's peacefulness. Inequality has less meaning to the richest group, but is substantially more important to the poorest group. The chances of not being in "complete peace" or likelihood of violence is driven by the poorest group, which form the majority of a country's population. The richest has an incentive to keep peace as it will retain their wealth, while the poorest will have an incentive to work and overturn the inequality. As for the outcome equation, only negative horizontal inequality (relative gap between mean national income and income level of the poorest group) has a significant positive effect on the likelihood of civil war. Higher ethnic discrimination, measured as the proportion of the largest discriminated ethnic group to the group in power, is also estimated to increase the likelihood of civil war. As before, the ZIP reports higher log likelihood values and smaller standard errors, with the Vuong test and AIC concluding that it is preferred to the standard probit.

Table 4.4: Probit and ZIP Regression of Civil War Prevalence with Income Inequality 1960-2013

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
Opportunity			
log real GDP	-0.180*	-1.002**	1.115**
	(0.073)	(0.037)	(0.208)
RGDPPC Growth	-2.537**	-2.039**	2.035*
	(0.507)	(0.543)	(1.037)
Pri Exports/GDP	-4.335**	-3.783**	
	(1.100)	(0.854)	
Pri Exports/GDP^2	6.581**	4.045**	
	(1.569)	(1.453)	
log % Mountains	0.013	0.096*	

Continued on next page

Table 4.4 – *Continued from previous page*

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
	(0.093)	(0.028)	
Grievance			
Polity Index	0.003	0.045**	-0.098*
	(0.007)	(0.007)	(0.051)
Polity Index^2	-0.010**	-0.012**	0.023**
	(0.001)	(0.001)	(0.006)
Eth Frac (C&H)	0.040†	0.026**	0.013
	(0.022)	(0.005)	(0.085)
Eth Frac^2 (C&H)	-0.001	-0.001**	
	(0.001)	(0.000)	
ldg	0.821**	1.161**	-19.76**
	(0.220)	(0.173)	(3.415)
phi	-0.137	-0.012	1.346**
	(0.150)	(0.070)	(0.383)
nhi	0.561**	0.088*	-0.969**
	(0.245)	(0.045)	(0.268)
Controls			
Population	0.552**	0.202**	-2.311**
	(0.124)	(0.045)	(0.380)
Cold War	0.008	-0.152*	
	(0.008)	(0.076)	
Constant	7.394**	-3.405**	4.450*
	(1.596)	(0.619)	(2.248)
Observations	4390	4390	
Zero Observations	-	3481	
Log likelihood	-1322.63	-1945.04	

Continued on next page

Table 4.4 – *Continued from previous page*

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
Wald χ^2	169.66	-	
Vuong test	-	9.30	
AIC	4838.92	3940.131	

Notes: AIC = Akaike Information Criterion; Dependent variable: Conflict prevalence; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1; ldg = largest discriminated ethnic group, phi = positive horizontal inequality (relative gap between mean national income and income level of the richest group), nhi = negative horizontal inequality (relative gap between mean national income and income level of the poorest group)

Other variants of the zero-inflated Poisson were estimated replacing primary commodity exports with either mineral dependence, oil production or oil export; replacing the polity index with the freedom house measure, democracy and autocracy dummies; substituting income variables with urbanisation rate and life expectancy and adding an Africa dummy. The results are shown to be relatively robust, with primary commodity dependence increasing civil war risk, democracy, political freedom and higher urbanisation decreasing civil war risk, and the Africa dummy having no special effect.[11]

The main results found in this chapter are two-fold. Firstly, unlike most historical articles, explanations of civil war risk seems to rest with both greed and grievance variables. Secondly, regressions of civil war prevalence seems to perform better using the zero-inflated Poisson than the ordinary probit models. The zero-inflated Poisson is able to statistically account for observable and latent factors that produce different types of peace observations. In this way the inflation equation was able to provide substantial understanding on the different types of peace observations and its data generating process.

[11]See Appendix Table A14 and A15 for the additional results.

The outcome equation also showed coefficients that are more accurate on conflict outcome than standard probits since estimations were conditional on the observation being able to experience a civil conflict.

Although the opportunity variables were always significant in both the standard probit and zero-inflated Poisson, it is the grievance variables that have provided the greatest insight. In the case of the ordinary probit, model misspecification has biased the estimates giving greater weighting to opportunity variables over grievance variables. This led to most empirical work finding opportunity or income variables as the main determinant of civil conflict and brandishing grievance type variables as having little explanatory power. As one takes a deeper look at what type of country is mostly associated with the always zero or "complete peace" group, the answer is often high income countries. By not distinguishing the different zeroes, the normal probit gave a likelihood of war calculation that included countries conditioned to not experience such an event. These countries' main attribute is high income, and thus income variables were estimated with greater emphasis and significance, crowding out the explanatory power of grievance variables.

By using a zero-inflated model and splitting the estimation process into two stages, greed and grievance variables are given equal emphasis which results in a clearer picture that both ethno-political and economic grievance matter, with substantial explanatory power in predicting civil war risk.

4.6 Conclusion

This chapter has made a contribution to the burgeoning literature on the determinants of civil conflict by highlighting the possible impact of using the standard probits or logits to model a situation when the binary conflict dependent variable is characterised by excess zeroes. In such cases, the zeroes are not homogeneous and these standard models are unable to account for the factors that produce the high proportion of zeroes. From a civil war perspective, there is a big difference between a zero that reflects peace in a

peaceful country and one that reflects a lull in conflict or where the number of battle deaths used in the definition of conflict falls below the threshold used to construct the variable. A more satisfactory approach has been suggested by Bagozzi et al. (2015), a zero-inflated model, which treats the excess zeroes as a heterogeneous group of observations, accounting for observable and unobservable factors that produce the different types of zeroes.

Applying this model to Elbadawi and Sambanis' (2002) data and using their model specification showed differing results with the grievance terms becoming significant predictors of civil war. Doing a similar exercise on an updated dataset of 134 countries for the period 1960 and 2013 and using a general greed-grievance empirical specification, provided further support for the need to recognise the problem of too many zeroes and a need to deal with it within a zero-inflated model framework. Estimates using the ZIP model were shown to have lower standard errors and higher log likelihood values than the probit model and a comparison between the probit and ZIP models again found substantial differences in the objective grievance variables. Unlike previous findings, civil war prevalence seems to be explained by both greed and grievance variables. Income, natural resource dependence, polity, ethnicity and income inequality were all found to play a significant role in explaining civil war prevalence. These are important results which suggest that if these models had been used earlier the trajectory of the greed versus grievance debate might have been quite different. The implications resulting from this chapter suggests a need for future research to recognise the heterogeneity of observations that have so far been treated as homogeneous peace and to assign values to zeroes in order to better understand the heterogeneous process which are generating these outcomes.

CHAPTER 5

Summary and Conclusion

5.1 Summary of Findings

This dissertation has contributed to the economics of peace and security literature by focusing on the interplay between military spending, armed conflict and economic growth. Specifically, intending to answer three questions: i) What is the true effect of military expenditure on economic growth after accounting for concerns of group heterogeneity and non-linearity? ii) Do the costs of armed conflict spillover onto neighbouring countries and how far does it reach? iii) What are the determinants of civil wars and are the correlates different when more appropriate rare event estimators are used? These three research questions are all interconnected and can have profound effects on development. Another way to think about this is that both expenditures in arms and conflict can have a negative impact on economic development. This negative influence can lead to a greater chance of conflict which in turn will further affect development, leaving affected nations in either a develop-

mental or conflict trap. To answer the above mentioned questions, the thesis develops three chapters with each exploring a relevant question.

Answering the first question, chapter two uses an exogenous Solow growth model and dynamic panel estimation techniques to analyse military expenditure's effect on economic growth. The use of a theoretical model (e.g. Solow growth model) allows for a definitive link between theory and econometrics, a link often missing in modern macroeconomic regressions. The empirical evidence shown in chapter two supports the view that military expenditure leads to lower growth in per capita GDP both in the short and long-run. Using a sample stratification approach, additional concerns of group heterogeneity and non-linearity were considered. The results were mostly consistent with the overall analysis of military spending having a negative and significant effect on growth. Only country sub-groups characterised as non-fuel resource abundant, as low aid recipients, closed economies, democratic, autocratic or middle income show military spending as having no burden on the economy. One intriguing finding is that of all the estimated regressions, there was no evidence of military expenditure having a positive effect on growth.

To answer the second question, chapter three adds to the literature on costs of conflict by focusing on the spillover effects it has on neighbouring countries' economic growth. Using a general growth framework and spatial econometric techniques, this chapter follows from the contributions of Murdoch and Sandler (2002b,a, 2004) and de Groot (2010) to develop a distance measure which includes economic and political similarities. This is considered to reflect a more holistic measurement of distance than the use of only geographic distance. The initial estimation results, using only geographic distance, suggest conflict to have a substantial negative spillover effect on neighbouring countries. This effect, however, is multidimensional and is limited to only directly contiguous neighbours, with non-contiguous neighgbours experiencing no significant harm from armed conflict.

Subsequent estimations of conflict spillover are regressed using the consolidated and new weighted matrix containing geographic, economic and political distance. The empirical results show that conflict, irrespective of its

type, has a significant and negative spillover effect on contiguous neighbours, an effect that is smaller in magnitude when compared to using geography alone as a distance element. The spillover effect on non-contiguous neighbours remains insignificant. Results from the new contiguity matrix suggest that studies using only geographic distance to measure conflict spillover have potentially overestimated its effects. As argued in chapter three, distance is more than just geography and important considerations are needed to be made on notions of economic and political distance.

Chapter four looks to answer the third question regarding civil war prevalence. It looks to address the concern of estimation bias, model misspecification and the appropriate estimator of rare events when there is a case of excess zeroes of a heterogeneous nature in the dependent variable. The contribution that this chapter makes to the empirical debate can be considered two-fold; it questions which technique is a more appropriate in determining civil war risk and secondly, it challenges the commonly held notion in economics that greed or opportunity are the main drivers of civil conflict. To determine the most appropriate estimation technique in civil war research, this study applies the ZIP model to a past study on civil war prevalence by Elbadawi and Sambanis (2002). This data replication shows substantial differences between the ZIP and the popular probit model used by Elbadawi and Sambanis. While previously the authors found variables relating to greed (e.g. GDP, GDP growth and natural resource dependence) as the only determinants of civil war prevalence, both greed and grievance variables become significant under the ZIP model. Variables such as ethnic diversity and polity, which were generally considered to have little explanatory power, are now estimated to be significant predictors if civil war. Moreover, the ZIP model is seen to outperform the more popular probit model.

With a better understanding of what constitutes a more appropriate estimation technique, a process similar to data replication is used on an updated data set to reconsider the greed versus grievance debate. Using a general greed-grievance specification, the estimation results provide further support to the view that both greed and grievance variables matter in explaining civil

war risk; a contrast to most empirical studies. The finding is also robust to various specification changes that include alternative measurements of both the opportunity and grievance variables. The results from this chapter implies that had scholars recognised sooner the concerns of excess zeroes, which lead to issues of model misspecification, biased estimates and appropriate estimators, the potential path of the determinants of civil conflict debate might be very different today.

5.2 Policy Implications

From a policy perspective there are important implications in all three chapters. Military spending has both short and long-term impacts on economic development that is not limited by income or development levels. Since this negative effect of military expenditure is quite universal, it is implied that governments looking to pursue growth need to cut their defence budgets. Evidence of this has already been witnessed amid austerity measures in the West - i.e. North America, West and Central Europe and Oceania. Military spending having no positive effects suggest that policy makers should not use military expenditure as a reason to pursue economic growth, but rather look to divert these funds to other areas such as education, infrastructure or healthcare. It must be noted that while the finding in chapter two shows military expenditure to have an overwhelmingly negative effect on growth, countries should not completely omit it from their budget. Security (internal and external) is seen as vital to economic growth, and defence spending should be viewed as a means to maintain it.

Turning to chapter three, two major policy implications can be noted from the empirical results on the investigation of conflict spillovers. First, since the costs of armed conflict can only be felt by contiguous neighbours and not non-contiguous neighbours within the conflict vicinity, governments, international donors or organisations implementing policies targeting conflict recovery should prioritise host nations and contiguous neighbours. Moreover,

evidence suggests that irrespective of the amount or type of assistance aid needed, these various institutions must consider all types of armed conflict and not just the most violent ones.

Finally, the findings in chapter four can be regarded as imperative to understanding the etiology of civil war, how to prevent future wars and creating a initial foundation for persistent economic growth. Implications to chapter four's finding that civil conflict occurrence is likely to be explained by both greed (e.g income, natural resources) and grievance (e.g. social and income inequality, ethnic fractionalisation, democracy) variables is two-fold. Firstly, over and above the growth and income related challenges, addressing issues on social inequality could greatly reduce civil war risk. Secondly, since half of all civil wars are post-conflict collapses, these greed and grievance variables which explain civil war can be seen to offer some insight on the types of societies that remain in the aftermath of a civil conflict. A case of low income, slow economic growth, poor social structure (e.g. social alienation), absence of democracy, and high inequality are potentially just some characteristics that not only cause civil conflict, but are left behind post-conflict. Thus, there is a need for scholars and policy makers to address issues of post-conflict recovery and relapse inconjunction with causes of civil war.

5.3 Suggestions for Future Research

This thesis has provided a clear and concise foundation between the topics of military spending, armed conflict and economic growth, paving the way for innovative future research. From a military spending and growth nexus perspective, future research can investigate the issue of endogeneity. Questions have always been raised regarding the exogeneity of the military spending variable in the growth equation, with scholars arguing that since military expenditure is part of a governments budget, it will be affected by changes in growth. Here the focus will be on the creation of a suitable instrument which is correlated with military spending, but uncorrelated with growth. Another

fruitful research extension is to find the turning point of military spending. This turning point will represent the optimal amount of military spending needed for security purposes, but also enough to not hinder developmental opportunities.

While the analysis in chapter four found armed conflict in a host country to have substantially negative spillover impacts on directly contiguous nations, it would be useful for future research to assess the sources of these spillovers. Empirical work should proceed towards testing whether these spillover effects are primarily through channels of capital, labour, trade or conflict; hence providing researchers and policy makers with a clearer understanding of the spillover dynamics. Although the findings here suggest the spillover effects to be limited to contiguous neighbours, there is uncertainty about the exact distance of this effect. It would be interesting to determine at what distance from the host nation the spillover effect become significant and how many non-contiguous countries it would include.

Continuing with research on armed conflict, from a determinants perspective, more effort needs to be invested in recognising the heterogeneity in the observations (e.g. dependent variable) that have so often been treated as homogeneous. Moreover, researchers should look to explore the heterogeneous processes that are generating these various zeroes and how to model this from a theoretical perspective. Since the results from updated datasets challenge the previously held consensus, scholars can also use this initiative and explore new avenues, where the focus can shift towards understanding more about the grievance variables. Lastly, as mentioned, considering that over half of all civil wars are post conflict collapses, research on one cannot exist without the other and thus any future research on determinants of civil war should reflect a consideration of post-conflict societies.

Bibliography

Acemoglu, D., Johnson, S., and Robinson, J. A. (2005). *Institutions as a fundamental cause of long-run growth*, volume 1A of *Handbook of Economic Growth*. Elsevier.

Aizenman, J. and Glick, R. (2006). Military expenditure, threats and growth. *Journal of International Trade and Economic Development*, 15(2):129–155.

Alexander, W. R. J. (1990). The impact of defence spending on economic growth. *Defence and Peace Economics*, 2(1):39–55.

Alptekin, A. and Levine, P. (2012). Military expenditure and economic growth: a meta-analysis. *European journal of Political economy*, 28:636–650.

Bagozzi, B. E., Hill, D. W., Moore, W. H., and Mukherjee, B. (2015). Modelling two types of peace: the zero-inflated order probit (ziop) model in conflict research. *Journal of Conflict Resolution*, 59(4):728–752.

Barro, R. J. (1991). Economic growth in a cross section of countries. *Quarterly Journal of Economics*, 106(2):407–413.

Barro, R. J. and Lee, J. (2012). A new data set of educational attainment in the world, 1950-2010. *Journal of development economics*, 104:184–198.

Barro, R. J. and Sala-i Martin, X. (1992). Convergence. *Journal of Political Economy*, 100(2):223–251.

Beck, N. L., Gleditsch, K. S., and Beardsley, K. C. (2006). Space is more than geography: Using spatial econometrics in the study of political economy. *International Studi*, 50(1):27–44.

Benoit, E. (1973). *Defense and growth in developing countries*. Lexington Books, Boston, MA.

Benoit, E. (1978). Growth and defense in developing countries. *Economic Development and Cultural Change*, 34(2):261–275.

Benoit, K. (1996). Democracies really are more pacific (in general): Reexamining regime type and war involvement. *Journal of Conflict Resolution*, 40(4):636–657.

Besley, T. and Persson, T. (2010). State capacity, conflict and development. *Econometrica*, 78(1):1–34.

Besley, T. and Persson, T. (2014). The causes and consequences of development clusters: state capacity, peace and income. *Annual Reviews of Economics*, 6:927–949.

Black, N. (2013). When have violent civil conflicts spread? introducing a new dataset of substate conflict contagion. *Journal of Peace Research*, 50(6):751–759.

Blattman, C. and Miguel, E. (2010). Civil war. *Journal of Economic Literature*, 48(1):3–57.

Bosker, M. and Ree, J. (2014). Ethnicity and the spread of civil war. *Journal of Development Economics*, 108:206–221.

Buhaug, H., Cederman, L., and Gleditsch, K. S. (2014). Square pegs in round holes: inequalities, grievances and civil war. *International Studies Quarterly*, 58:418–431.

Burnside, C. and Dollar, D. (2000). Aid, policies and growth. *American economic review*, 90(4):847–868.

Cameron, C. and Trivedi, P. K. (2010). *Microeconometrics Using Stata*. Revised Edition. Stata Press, 2 edition.

Cerra, V. and Saxena, S. C. (2008). Growth dynamics: the myth of economic recovery. *American Economic Review*, 98(1):439–457.

Coghlan, B., Ngoy, P., Mulumba, F., Hardy, C., Bemo, V. N., Stewart, T., Lewis, J., and Brennan, R. (2007). Mortality in the democractic republic of congo: An ongoing crisis.

Collier, P. (1999). On the economic consequences of civil war. *Oxford Economic Papers*, 51(1):168–183.

Collier, P., Elliot, V., Hegre, H., Reynoal-Querol, M., and Sambanis, N. (2003). *Breaking the conflict trap*. Civil war and development policy. World Bank and Oxford University Press.

Collier, P. and Hoeffler, A. (1998). On economic causes of civil war. *Oxford Economic Papers*, 50:563–573.

Collier, P. and Hoeffler, A. (2004). greed and grievance in civil war. *Oxford economic papers*, 56(4):563–595.

Collier, P., Hoeffler, A., and Soderbom, M. (2004). On the duration of civil war. *Journal of peace research*, 41(3):253–273.

Conley, T. G. and Ligon, E. (2002). Economic distance and cross country spillovers. *Journal of economic growth*, 7(2):157–187.

Coulomb, F. and Bellais, R. (2008). The marxist analysis of war and military expenditures, between certainty and uncertainty. *Defence and Peace Economics*, 19(5):351–359.

Cunningham, D. E. and Lemke, D. (2014). Beyond civil war: A quantitative examination of causes of violence within countries. *Civil wars*, 16(3):328–345.

de Groot, O. J. (2010). The spillover effects of conflict on economic growth in neighbouring countries in africa. *Defence and Peace Economics*, 21(2):149–164.

Deng, F. M. (2001). Sudan - civil war and genocide. *Middle East Quarterly*, 8(1):13–21.

Dollar, D. and Kraay, A. (2004). Trade, growth and poverty. *Economic Journal*, 114(493):22–49.

Dunne, J. P. (1996). *Economic effects of military expenditure in developing countries: A survey*. Making Peace Pay. Regina Books, Claremont, CA.

Dunne, J. P. (2012). Military expenditure, growth, developmen and conflict. *Defence and Peace Economics*, 23(6):549–557.

Dunne, J. P. (2013). *Armed Conflicts*. Global Problems, Smart Solutions Costs and Benefits. Cambridge University Press, Cambridge.

Dunne, J. P. and Coulomb, F. (2008). *Peace, war and international security: economic theories*, volume 6 of *War, Peace and Security (Contributions to Conflict Management, Peace Economics and Development)*. Emerald Group Publishing Limited.

Dunne, J. P., Nikolaidou, E., and Smith, R. (2002). Military spending, investment and economic growth in small industrialised economies. *South African Journal of Economics*, 70(5):789–808.

Dunne, J. P., Smith, R., and Willenbockel, D. (2005). Models of military expenditure and growth: a critical review. *Defence and Peace Economics*, 16(6):449–461.

Dunne, J. P. and Tian, N. (2013). Military expenditure and economic growth: A survey. *The economics of peace and security journal*, 8(1):5–11.

Dunne, J. P. and Tian, N. (2015). Military expenditure, economic growth and heterogeneity. *Defence and Peace Economics*, 26(1):15–31.

Dunne, J. P. and Uye, M. (2010). *Military spending and development*. The global arms trade. Routledge, London.

Easterly, W., Levine, R., and Roodman, D. (2004). Aid, policies and growth: comment. *American Economic Review*, 94(3):774–780.

Edwards, S. (1998). Openness, productivity and growth: what do we really know? *Economic Journal*, 108:383–389.

Elbadawi, I. and Sambanis, N. (2002). How much war will we see? explaining the prevalence of civil war. *Journal of conflict resolution*, 46(3):307–334.

Fearon, J. D. (2004). Why do some civil wars last so much longer than others? *Journal of Peace Research*, 41(3):275–301.

Fearon, J. D. (2005). Primary commodity exports and civil war. *Journal of Conflict Resolution*, 49(4):483–507.

Fearon, J. D. and Laitin, D. D. (2003). Ethnicity, insurgency and civil war. *The american political science review*, 97(1):75–90.

Frankel, J. A. and Romer, D. (1999). Does trade cause growth? *American Economic Review*, 89(3):379–399.

Gleditsch, K. S. (2007). Transnational dimensions of civil war. *Journal of Peace Research*, 44(3):293–309.

Gleditsch, K. S. and Ward, M. D. (2001). Measuring space: a minimum distance database and applications to international studies. *Journal of Peace Research*, 38(6):749–768.

Gottheil, F. M. (1986). Marx versus marxist on the role military production in capitalists economies. *Journal of Post Keynesian Economics*, 89(3):379–399.

Grebe, J. and Sommer, J. (2010). Greece: High military expenditure despite the financial crisis. BICC Policy Brief 9.

Grier, K. B. and Tullock, G. (1989). An empirical analysis of cross national economic growth. *Journal of Monetary Economics*, 44(3):293–309.

Gyimah-Brempong, K. and Corley, M. E. (2005). Civil wars and economic growth in sub-saharan africa. *Journal of African Economies*, 14(2):270–311.

Haglund, D. (2011). Blessing or curse? the rise of mineral dependence among low and middle-income countries. Technical report, Oxford.

Hall, D. B. (2000). Zero-inflated poisson and binomial regression with random effects: a case study. *Biometrics*, 56:1030–1039.

Hansen, H. and Tarp, E. (2000). Aid effectiveness disputed. *Journal of International Development*, 12(3):375–398.

Harris, M. N. and Zhao, X. (2007). A zero-inflated ororder probit model, with an application to modelling tobacco consumption. *Journal of Econometrics*, 141(2):1073–1099.

Hegre, H., Ellingsen, T., Gates, S., and Gleditsch, N. P. (2001). Towards a democratic civil peace? democracy, political change and civil war. *American Political Science Review*, 95(1):33–48.

Hoeffler, A. (2012). *On the causes of civil war*. The oxford handbook of the economcis of peace and conflict. Oxford University Press.

Hsiang, S. M., Burke, M., and Miguel, E. (2013). Quantifying the influence of climate on human conflict. *Science*, 341(6151):1235367.

Humphreys, M. (2005). Natural resources, conflict, and conflict resolution: uncovering the mechanisms. *Journal of Conflict Resolution*, 49(4):508–537.

Islam, N. (1995). Growth empirics: A panel data approach. *Quarterly Journal of Economics*, 110(4):1127–1170.

Jaggers, K. and Gurr, T. R. (1995). Tracking democracy's third wave with the polity iii data. *Journal of Peace Research*, 32(4):469–482.

Justino, P. and Verwimp, P. (2006). Poverty dynamics, violent conflict and convergence in rwanda. *Houses in Conflict Network Working Paper*, 16.

Keen, D. (1998). The economic functions of violence in civil wars (special issue). *The Adelphi Papers*, 38(320):1–89.

Knight, M., Loayza, N., and Villanueva, D. (1996). The peace dividend: military spending cuts and economic growth. *IMF Staff Papers*, 43:1–44.

Lacina, B. and Gleditsch, N. P. (2005). Monitoring trends in global combat: A new dataset of battle deaths. *European Journal of Population*, 21:145–166.

Lambert, D. (1992). Zero-inflated poisson regression, with an application to defects in manufacturing. *Technometrics*, 34(1):1–14.

Lemke, D. and Cunningham, D. E. (2009). Distinctions without differences? comparing civil and interstate wars. APSA 2009 Toronto Meeting Paper.

Looney, R. E. and McNab, R. (2008). Can economic liberalisation and improved governance alter the defense-growth trade-off? *Review of financial economics*, 17(3):172–182.

Mankiw, G. N., Romer, D., and Weil, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, 107(2):407–437.

Miguel, E. and Roland, R. (2006). The long run impact of bombing vietnam. *National Bureau of Economic Research Working Paper*, 11954.

Miguel, E., Satyanath, S., and Sergenti, E. (2004). Economic shocks and civil conflict: An instrumental variables approach. *Journal of Political Economy*, 112(4):725–753.

Montalvo, J. G. and Reynal-Querol, M. (2005). Ethnic polarization, potential conflict and civil wars. *American Economic Review*, 95(3):796–816.

Murdoch, J. C. and Sandler, T. (2002a). Civil wars and economic growth: A regional comparison. *Defence and Peace Economics*, 13(6):451–464.

Murdoch, J. C. and Sandler, T. (2002b). Economic growth, civil wars and spatial spillovers. *Journal of Conflict Resolution*, 46(1):91–110.

Murdoch, J. C. and Sandler, T. (2004). Civil wars and economic growth: Spatial dispersion. *American Journal of Political Science*, 48(1):138–151.

Mylonidis, N. (2008). Revisiting the nexus between military spending and growth in the european union. *Defence and Peace Economics*, 19(4):265–272.

Organski, A. F. K. and Kugler, J. (1980). *The war ledger*. University of Chicago Press, Chicago.

Pieroni, L. (2009). Military spending and economic growth. *Defence and Peace Economics*, 20(4):327–339.

Polachek, S. W. (2007). How trade affects international interactions. *Economics of Peace and Security Journal*, 2(2):60–68.

Ram, R. (1995). *Defense expenditure and economic growth*. Handbook of Defense Economics. Elsevier, Amsterdam.

Reynal-Querol, M. (2002). Political systems, stability and civil wars. *Defence and Peace Economics*, 13(6):465–483.

Richardson, L. F. (1960). *Statistics of deadly quarrels*. Boxwood Press, Pittsburg.

Riddle, T. (1986). Marxism and military spending. *Journal of Post Keynesian Economics*, 8(4):574–580.

Robinson, J. A., Torvik, R., and Verdier, T. (2006). Political foundations of the resource curse. *Journal of Development Economics*, 79:447–468.

Rodriguez, F. and Rodrik, D. (2000). *Trade policy and economic growth: a skeptic's guide to cross-national evidence*. Macroeconomics Annual 2000. MIT Press.

Rodrik, D. (1999). Where did all the growth go? external shocks, social conflict and growth collapses. *Journal of Economic Growth*, 4(4):385–412.

Romer, D. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5):71–102.

Ross, M. L. (2006). A closer look at oil, diamonds, and civil war. *Annual Review of Political Science*, 9:265–300.

Ross, M. L. (2013). Oil and gas data, 1932-2011. Harvard Dataverse.

Ruttan, V. W. (2006). *Is war necessary for economic growth? Military procurement and technology development*. Oxford University Press, New York.

Salehyan, I. and Gleditsch, K. S. (2006). Refugees and the spread of civil war. *International organisation*, 60(2):335–366.

Sambanis, N. (2002). A review of recent advances and future directions in the quantitative literature of civil war. *Defence and Peace Economics*, 13(3):215–243.

Sambanis, N. (2004). What is civil war? conceptual and empirical complexities of an operational definition. *Journal of Conflict Resolution*, 48(6):814–858.

Sarr, M., Bulte, E., Meissner, C., and Swanson, T. (2011). On the looting of nations. *Public choice*, 148:353–380.

Simmons, J. P., Nelson, L. D., and Simonsohn, U. (2011). False-positives psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science*, 22(11):1359–1366.

SIPRI (2014). Trends in world military expenditure 2013.

Smaldone, J. P. (2006). Africa military spending: defense versus development. *African security review*, 15(4):18–32.

Smith, R. (2000). *Defence Expenditure and economic growth*. Making Peace Pay: A Bibliography on Disarmament and Conversion. Regina Books, Claremont, CA.

Smith, R. and Tasiran, A. (2012). The onset of peace. *Economics of Peace and Security Journal*, 7(1):5–14.

Stroup, S. G. and Sharp, S. J. (2001). Size of the military sector and economic growth: A panel analysis of africa and latin america. *Journal of Applied Economics*, 5:326–360.

Themner, L. and Wallensteen, P. (2011). Armed conflicts, 1946-2010. *Journal of Peace Research*, 48(4):525–536.

Themner, L. and Wallensteen, P. (2014). Armed conflicts, 1946-2013. *Journal of Peace Research*, 51(4):541–554.

Thompson, E. (1974). Taxation and national defense. *Journal of Political Economy*, 82(3):56–97.

Tiwari, A. K. and Shahbaz, M. (2012). Does defence spending stimulate economic growth in india? a revisit. *Defence and Peace Economics*, 24(4):371–395.

Vance, C. and Ritter, N. (2014). Is peace a missing value or a zero? on selection mmodel in political science. *Journal of Peace Research*, 51(4):528–540.

Vuong, Q. H. (1989). Likelihood ratio tests for model selection and non-nested hypothesis. *Econometrica*, 57(2):307–333.

Watts, D. J. and Strogatz, S. H. (1998). Collective dynamics of small world networks. *Nature*, 393:440–442.

Wilkinson, D. O. (1980). *Deadly quarrels: Lewis F. Richardson and the Statistical Study of War*. University of California Press, Berkeley, CA.

Yakovlev, P. (2007). Arms trade, military spending and economic growth. *Defence and Peace Economics*, 18(4):317–338.

Yanikkaya, H. (2003). Trade openness and economic growth: a cross-country empirical investigation. *Journal of Development Economics*, 72:57–89.

Young, A. (2012). The african growth miracle. *NBER Working Paper Series*, (18490):1–48.

APPENDIX A

Appendix

A.1 Appendix for Chapter 2

Table A.1: List of Countries in Full Sample

Africa	Asia & Oceania	Europe	Americas	Middle East
Algeria	Australia	Albania	Argentina	Bahrain
Angola	Bangladesh	Austria	Belize	Iran
Botswana	Brunei	Belgium	Bolivia	Israel
Burkina Faso	Cambodia	Bulgaria	Brazil	Jordan
Burundi	China, P. R.	Cyprus	Canada	Kuwait
Cameroon	Fiji	Denmark	Chile	Lebanon
Djibouti	India	Finland	Colombia	Oman
Egypt	Indonesia	France	Dom. Rep	Saudi Arabia
Ethiopia	Japan	Germany	Ecuador	Syria
Ghana	Korea, South	Greece	El Salvador	
Kenya	Malaysia	Hungary	Guatemala	
Lesotho	Mongolia	Ireland	Haiti	
Madagascar	Nepal	Italy	Jamaica	
Malawi	New Zealand	Luxembourg	Mexico	
Mali	Pakistan	Malta	Nicaragua	
Mauritania	P.N. Guinea	Netherlands	Panama	
Mauritius	Philippines	Poland	Paraguay	
Morocco	Singapore	Portugal	Peru	
Mozambique	Sri Lanka	Romania	Uruguay	
Namibia	Thailand	Russia	U.S.A.	
Nigeria		Portugal	Venezuela	
Rwanda		Spain		
Senegal		Sweden		
Seychelles		Switzerland		
Sierra Leone		Turkey		
South Africa		U.K.		
Swaziland				
Tanzania				
Tunisia				
Uganda				

Table A.2: List of Countries in Various Sub-samples

High Inc	Med Inc	Low Inc	Conflict	Civil War
Australia	Albania	Angola	Algeria	Algeria
Austria	Algeria	Bangladesh	Angola	Angola
Bahrain	Argentina	Belize	Australia	Bangladesh
Belgium	Botswana	Bolivia	Bangladesh	Burundi
Canada	Brazil	Burkina Faso	Burundi	Cambodia
Cyprus	Brunei	Burundi	Cambodia	Colombia
Denmark	Bulgaria	Cambodia	Cameroon	Djibouti
Finland	Chile	Cameroon	Colombia	Egypt
France	China, P. R.	Djibouti	Cameroon	Ethiopia
Germany	Colombia	Egypt	Colombia	Guatamala
Greece	Dom. Rep.	El Salvador	India	India
Hungary	Ecuador	Ethiopia	Indonesia	Indonesia
Ireland	Iran	Fiji	Iran	Iran
Israel	Jamaica	Ghana	Israel	Israel
Italy	Jordan	Guatamala	Kuwait	Lebanon
Japan	Lebanon	Haiti	Lebanon	Mali
Korea. S	Malaysia	India	Mali	Morocco
Kuwait	Mauritius	Indonesia	Morocco	Mozambique
Luxembourg	Mexico	Kenya	Mozambique	Nepal
Malta	Namibia	Lesotho	Nepal	Nicaragua
Netherlands	Panama	Madagascar	Nicaragua	Pakistan
Norway	Peru	Malawi	Nigeria	Paraguay
Oman	Romania	Mali	Pakistan	Peru
Poland	Russia	Mauritania	Paraguay	Philippines
Portugal	Seychelles	Mongolia	Peru	Russia
Saudi Arabia	S. Africa	Morocco	Philippines	Rwanda
Singapore	Thailand	Mozambique	Russia	Senegal
Spain	Tunisia	Nepal	Rwanda	Sierra Leone
Sweden	Turkey	Nicaragua	Senegal	S. Africa
Switzerland	Uruguay	Nigeria	Sierra Leone	Sri Lanka
U.K.	Venezuela	Pakistan	S. Africa	Turkey
U.S.A.		P.N. Guinea	Sri Lanka	U.K.
		Paraguay	Turkey	Uganda
		Philippines	U.K.	
		Rwanda	Uganda	
		Senegal	U.S.A.	
		Sierra Leone		
		Sri Lanka		
		Swaziland		
		Syria		
		Tanzania		
		Uganda		

Table A.3: List of Countries in Various Sub-samples

Nat.	No Nat. Resources		Aid Received	
Algeria	Albania	Malawi	Albania	Malta
Angola	Argentina	Malaysia	Algeria	Mauritania
Australia	Austria	Malta	Angola	Mauritius
Bahrain	Bangladesh	Mauritius	Bahrain	Mongolia
Belize	Belgium	Mexico	Bangladesh	Morocco
Bolivia	Brazil	Morocco	Belize	Mozambique
Botswana	Bulgaria	Nepal	Bolivia	Namibia
Brunei	Burundi	Netherlands	Botswana	Nepal
Burkina Faso	Cambodia	New Zealand	Burkina Faso	Nicaragua
Cameroon	Canada	Nicaragua	Burundi	Nigeria
Chile	China, P.R	Pakistan	Cambodia	Oman
Colombia	Cyprus	Panama	Cameroon	Pakistan
Ecuador	Denmark	Paraguay	Chile	Panama
Egypt	Djibouti	Philippines	Colombia	P.N Guinea
Ghana	Dom. Rep.	Poland	Djibouti	Paraguay
Iran	El Salvador	Portugal	Dom. Rep.	Peru
Israel	Ethiopia	Romania	Ecuador	Philippines
Jamaica	Fiji	Seychelles	Egypt	Rwanda
Kuwait	Finland	Singapore	El Salvador	Senegal
Mali	France	Spain	Ethiopia	Seychelles
Mauritania	Germany	Sri Lanka	Fiji	Sierra Leone
Mongolia	Greece	Swaziland	Ghana	S. Africa
Mozambique	Guatemala	Sweden	Guatemala	Sri Lanka
Namibia	Haiti	Switzerland	Haiti	Swaziland
Nigeria	Hungary	Thailand	India	Syria
Norway	India	Tunisia	Indonesia	Tanzania
Oman	Indonesia	Turkey	Iran	Thailand
P.N Guinea	Ireland	U.K.	Israel	Tunisia
Peru	Italy	Uganda	Jamaica	Uganda
Russia	Japan	U.S.A.	Jordan	Uruguay
Rwanda	Jordan	Uruguay	Kenya	
Saudi Arabia	Kenya		Lebanon	
Senegal	Korea. S		Lesotho	
Sierra Leone	Lebanon		Madagascar	
S. Africa	Lesotho		Malawi	
Syria	Luxembourg		Malaysia	
Tanzania	Madagascar		Mali	

Table A.4: List of Countries in Various Sub-samples

No Aid	Open		Closed	Interstate War
Argentina	Albania	Madagascar	Argentina	Australia
Australia	Algeria	Malawi	Australia	Cameroon
Austria	Angola	Malaysia	Bangladesh	Ecuador
Belgium	Austria	Malta	Brazil	Ethiopia
Brazil	Bahrain	Mauritania	Burkina Faso	India
Brunei	Belgium	Mauritius	Burundi	Iran
Bulgaria	Belize	Mexico	Cameroon	Kuwait
Canada	Bolivia	Mongolia	China, P.R	Nigeria
China, P.R	Botswana	Morocco	Colombia	Pakistan
Cyprus	Brunei	Mozambique	Egypt	Peru
Denmark	Bulgaria	Namibia	Ethiopia	U.K.
Finland	Cambodia	Netherlands	India	U.S.A.
France	Canada	New Zealand	Iran	
Germany	Chile	Nicaragua	Japan	
Greece	Cyprus	Nigeria	Nepal	
Hungary	Denmark	Norway	Pakistan	
Ireland	Djibouti	Oman	Peru	
Italy	Dom. Rep.	Panama	Rwanda	
Japan	Ecuador	P.N. Guinea	Turkey	
Korea. S	El Salvador	Paraguay	Uganda	
Kuwait	Fiji	Sri Lanka	U.S.A	
Luxembourg	Finland	Poland	Uruguay	
Mexico	France	Portugal	Venezuela	
Netherlands	Germany	Romania		
New Zealand	Greece	Russia		
Norway	Guatemala	Saudi Arabia		
Poland	Haiti	Senegal		
Portugal	Hungary	Seychelles		
Romania	Indonesia	Sierra Leone		
Russia	Ireland	Singapore		
Saudi Arabia	Israel	S. Africa		
Singapore	Italy	Spain		
Spain	Jamaica	Sri Lanka		
Sweden	Jordan	Swaziland		
Switzerland	Kenya	Sweden		
Turkey	Korea. S	Switzerland		
U.K.	Kuwait	Syria		
U.S.A.	Lebanon	Thailand		
Venezuela	Lesotho	U.K.		

Table A.5: Growth Effects of Military Expenditure, Stratifying for Conflict and Income

	(1)	(2)	(3)
Sample	Conflict & Low	Conflict & Medium	Conflict & High
Variables	Δly	Δly	Δly
Δlk	0.021†	0.189**	0.087**
	(0.011)	(0.026)	(0.028)
Δlm	-0.034**	-0.019	-0.113**
	(0.009)	(0.012)	(0.031)
$lngdpop$	-0.030*	-0.014	-0.070*
	(0.015)	(0.061)	(0.029)
$ly1$	-0.106**	-0.147**	-0.449**
	(0.014)	(0.032)	(0.048)
$lk1$	0.025**	0.032	0.092**
	(0.009)	(0.020)	(0.027)
$lm1$	-0.028**	-0.006	-0.057**
	(0.006)	(0.007)	(0.015)
$Constant$	-5.793**	-6.131**	-11.228
	(0.782)	(1.496)	(1.925)
Trend	Yes	Yes	Yes
LR Coefficient	-0.264	-0.041	-0.127
Observations	487	190	98
R-squared	0.214	0.402	0.574

Dependent variable: Δly; Standard errors in parentheses; Significance levels: ** p<0.01, * p<0.05, † p<0.1

Table A.6: Growth Effects of Military Expenditure, Stratifying for Trade Openness

	(1)	(2)	(3)	(4)
Sample	Open 2000	Closed 2000	Open 2010	Closed 2010
Variables	Δly	Δly	Δly	Δly
Δlk	0.053**	0.162**	0.058**	0.180**
	(0.007)	(0.013)	(0.007)	(0.016)
Δlm	-0.033**	-0.011	-0.026**	-0.019†
	(0.006)	(0.008)	(0.006)	(0.010)
$lngdpop$	-0.048**	-0.064**	-0.052**	-0.063**
	(0.011)	(0.014)	(0.011)	(0.014)
$ly1$	-0.103**	-0.061**	-0.079**	-0.176**
	(0.009)	(0.012)	(0.008)	(0.021)
$lk1$	0.024**	0.050**	0.027**	0.068**
	(0.006)	(0.010)	(0.005)	(0.012)
$lm1$	-0.023**	-0.007	-0.015**	-0.013*
	(0.004)	(0.005)	(0.004)	(0.006)
$Constant$	-3.021**	-4.007**	-3.042**	-5.994**
	(0.496)	(0.610)	(0.459)	(0.770)
Trend	Yes	Yes	Yes	Yes
LR Coefficient	-0.223	-0.115	-0.190	-0.074
Observations	1656	508	1762	402
R-squared	0.127	0.331	0.111	0.414

Dependent variable: Δly; Standard errors in parentheses; Significance levels: ** p<0.01, * p<0.05, † p<0.1

A.2 Appendix for Chapter 3

Figure A.1: Map of Africa: An Example on the Choice of Primary and Secondary Neighbours

Table A.7: Growth Effects of Conflict using Returns to Human Capital (Penn World Tables 8.0

	(1)	(2)	(3)	(4)
Conflict Type		Conflict	Intense	Civil
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\Delta \ln(inv)$	0.036**	0.036**	0.036**	0.036**
	(0.006)	(0.006)	(0.005)	(0.006)
$\Delta \ln(edu)$	-0.073**	-0.069*	-0.067*	-0.070**
	(0.027)	(0.027)	(0.027)	(0.027)
$\ln(n+g+\delta)$	0.092**	0.089**	0.090**	0.093**
	(0.012)	(0.012)	(0.012)	(0.012)
$\ln(y0)$	-0.024**	-0.026**	-0.026**	-0.025**
	(0.005)	(0.005)	(0.005)	(0.005)
$\ln(inv_{t-1})$	0.018**	0.018**	0.018**	0.018**
	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu_{t-1})$	-0.023**	-0.021**	-0.022**	-0.022**
	(0.004)	(0.004)	(0.004)	(0.005)
Conflict		-0.015**	-0.024**	-0.012*
		(0.005)	(0.007)	(0.005)
Year	0.001**	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.989**	-1.922**	-1.968**	-1.967**
	(0.540)	(0.538)	(0.538)	(0.539)
Observation	1765	1765	1765	1765
R-squared	0.096	0.102	0.101	0.100

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table A.8: Growth Effects of Conflict with Combined Political and Economic Contiguity Matrices

	(1)	(2)	(3)
Conflict:	Conflict	Intense	Civil
Weight:	Polity + Trade	Polity + Trade	Polity + Trade
Pri	Border	Border	Border
Sec	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.014**	0.022**	-0.012**
	(0.005)	(0.007)	(0.005)
$W_{pri}Conf_{pri}$	-0.010*	-0.014*	-0.013**
	(0.005)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.007	-0.006	-0.010
	(0.006)	(0.009)	(0.006)
Constant	-1.838**	-1.851**	-2.045**
	(0.538)	(0.540)	(0.540)
Observations	1765	1765	1765
R-Squared	0.105	0.104	0.104

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table A.9: Growth Effects of Conflict using Different Datasets and Removing Outlier Countries

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict Type:	Conflict		Intense		Civil	
Weight Type:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.016**	-0.016**	-0.028**	-0.028**	-0.013*	-0.013*
	(0.004)	(0.005)	(0.009)	(0.008)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.011†	-0.009†	-0.019*	-0.014†	-0.011*	-0.012*
	(0.006)	(0.005)	(0.009)	(0.008)	(0.007)	(0.006)
$W_{sec}Conf_{sec}$	-0.001	-0.006	-0.014	-0.002	-0.011	-0.008
	(0.009)	(0.006)	(0.013)	(0.010)	(0.009)	(0.007)
Constant	-2.202**	-2.159**	-2.119**	-2.195**	-2.344**	-2.233**
	(0.562)	(0.563)	(0.565)	(0.564)	(0.564)	(0.564)
Observations	1635	1635	1635	1635	1635	1635
R-squared	0.112	0.113	0.115	0.113	0.110	0.111

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table A.10: Growth Effects of Conflict Following Murdoch and Sandler (2002) and de Groot (2010)'s Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict Type:	Conflict		Intense		Civil	
Weight Type:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\ln(invest)$	0.022**	0.022**	0.020**	-0.020**	0.021**	0.022**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu)$	-0.020**	-0.021**	-0.020**	-0.021**	-0.021**	-0.021**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$\ln(n+g+\delta)$	0.089**	0.090**	0.092**	0.089**	0.092**	0.093**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
$\ln(y0)$	-0.030**	-0.030**	-0.029**	-0.028**	-0.029**	-0.028**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Conflict	-0.015**	-0.015**	-0.023**	-0.024**	-0.012*	-0.012*
	(0.007)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.013*	-0.011*	-0.016*	-0.011†	-0.014*	-0.013**
	(0.006)	(0.005)	(0.008)	(0.006)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.005	-0.009	-0.020	-0.005	-0.014	-0.011†
	(0.009)	(0.006)	(0.012)	(0.009)	(0.009)	(0.006)
Constant	-1.866**	-1.842**	-1.765**	-1.857**	-2.018**	-1.926**
	(0.536)	(0.535)	(0.538)	(0.538)	(0.537)	(0.536)
Observations	1768	1768	1768	1768	1768	1768
R-squared	0.097	0.098	0.098	0.095	0.096	0.097

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table A.11: Growth Effects of Conflict using Conflict Duration, with Polity and Trade Contiguity Weights

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict Type:	Conflict		Intense		Civil	
Weight Type:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.015**	-0.015**	-0.023**	-0.024**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.004	-0.009*	-0.004	-0.002	-0.001	-0.004
	(0.004)	(0.004)	(0.013)	(0.012)	(0.007)	(0.006)
$W_{sec}Conf_{sec}$	-0.005	-0.002	-0.009	-0.003	-0.001	-0.003
	(0.009)	(0.006)	(0.021)	(0.022)	(0.001)	(0.007)
Constant	-1.829**	-1.748**	-1.899**	-1.915**	-1.937**	-1.891**
	(0.541)	(0.542)	(0.540)	(0.540)	(0.539)	(0.541)
Observations	1765	1765	1765	1765	1765	1765
R-squared	0.103	0.104	0.102	0.101	0.099	0.099

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table A.12: List of Countries and Conflict Years

Country	Years in Conflict	Years in Civil War
Algeria	23	17
Benin	0	0
Botswana	0	0
Burundi	17	17
Cameroon	4	2
Central African Republic	4	3
Congo DR	17	10
Congo Republic	5	1
Cote d'Ivoire	3	3
Egypt	10	6
Gabon	1	0
Gambia	1	0
Ghana	3	3
Kenya	1	1
Lesotho	1	1
Liberia	7	7
Malawi	0	0
Mali	6	5
Mauritania	5	4
Mauritius	0	0
Morocco	17	15
Mozambique	27	10
Namibia	0	0
Niger	6	8
Rwanda	14	11
Senegal	9	9
Sierre Leone	11	0
South Africa	23	23
Sudan	39	38
Swaziland	0	0
Tanzania	1	0
Togo	1	1
Tunisia	2	1
Uganda	35	27
Zambia	0	0
Zimbabwe	9	8

A.3 Appendix for Chapter 4

Table A.13: Probit and ZIP Models of Civil War Prevalence, 1960 to 1999 using Alternative Specification

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
Pri Exports/GDP	10.566*	10.889**	
	(3.835)	(4.107)	
Pri Exports/GDP^2	-20.787*	-22.812*	
	(8.646)	(10.493)	
log real GDP	-0.0002**	-0.0002*	0.0018*
	(0.0001)	(0.0001)	(0.0006)
RGDPPC Growth	-0.0723**	-0.1461**	
	(0.0270)	(0.034)	
Polity Index (1 lag)	-0.0105	0.0341*	0.0674*
	(0.0183)	(0.0189)	(0.0301)
Polity Index^2 (1 lag)	0.0030	0.0133*	
	(0.0039)	(0.0055)	
Ethic Dominance	0.3619	0.5265*	1.0852
	(0.2909)	(0.2433)	(0.7788)
Log Population	0.4290**	0.4291**	-1.1070**
	(0.1217)	(0.1222)	(0.3131)
War in Past 10 Years	0.7353**	1.4194**	
	(0.2137)	(0.2629)	
Constant	-9.548**	-6.805**	11.753*
	(2.223)	(1.962)	(4.708)
Rho	0.4747**	-	
	(0.1049)	-	
Observations	783	783	

Continued on next page

Table A.13 – *Continued from previous page*

	(1)	(2)	
	Probit	ZIP	
	Outcome	Outcome	Inflation
Zero Observations	-	692	
Log likelihood	-184.481	-211.817	
Wald χ^2	51.82	-	
Vuong test	-	3.68	

Notes: Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05, † p<0.1

Table A.14: Additional Results of ZIP Model: Varying in Primary Commodity

	(1)		(2)		(3)	
	ZIP		ZIP		ZIP	
	Outcome	Inflation	Outcome	Inflation	Outcome	Inflation
Opportunity						
Min Dependence	0.287*					
	(0.075)					
Oil Export			0.148			
			(0.108)			
Oil Production					-0.042	
					(0.140)	
Oil Production^2					0.002	
					(0.005)	
log real GDP	-0.092*	-0.409**	-0.070	0.416*	-0.306**	0.249*
	(0.042)	(0.064)	(0.042)	(0.061)	(0.069)	(0.114)
RGDPPC Growth	-2.079**	-2.067	-2.342**	-1.418	-3.080**	-2.343
	(0.589)	(1.837)	(0.623)	(1.198)	(0.723)	(1.809)
log % Mountains	0.127**		0.101**		0.137**	
	(0.027)		(0.026)		(0.038)	
Grievance						
Polity Index	0.043**	0.078**	0.044**	0.073**	0.080**	0.318**
	(0.008)	(0.021)	(0.008)	(0.019)	(0.009)	(0.062)
Polity Index^2	-0.004**		-0.003**		-0.004**	
	(0.001)		(0.001)		(0.002)	
Eth Frac (F&L)	5.265**	1.191**	5.367**	1.187**	5.254**	1.123
	(0.737)	(0.384)	(0.741)	(0.374)	(1.037)	(0.656)
Eth Frac^2 (F&L)	-4.392**		-4.288**		-4.908**	
	(0.672)		(0.673)		(1.007)	
ldg	0.436*	-12.58**	0.374*	-12.39**	1.169**	-20.61**
	(0.191)	(1.704)	(0.192)	(1.621)	(0.288)	(3.585)

Continued on next page

Table A.14 – *Continued from previous page*

	(1)		(2)		(3)	
	ZIP		ZIP		ZIP	
	Outcome	Inflation	Outcome	Inflation	Outcome	Inflation
phi	-0.094	0.596**	-0.103	0.589**	-0.103	1.246**
	(0.091)	(0.091)	(0.098)	(0.088)	(0.105)	(0.185)
nhi	0.224*	-0.710**	0.195**	-0.774**	0.381**	-0.261
	(0.072)	(0.210)	(0.072)	(0.225)	(0.097)	(0.244)
Controls						
log Population	0.126**	-0.966**	0.104*	-0.943**	0.233**	-1.291**
	(0.049)	(0.086)	(0.048)	(0.081)	(0.097)	(0.198)
Cold War	-0.117		-0.095		-0.225*	
	(0.073)		(0.075)		(0.095)	
Africa	0.126		0.172		0.630**	
	(0.096)		(0.096)		(0.143)	
Constant	-2.768**	5.591**	-2.788**	5.128**	0.389	13.058**
	(0.742)	(1.091)	(0.754)	(1.000)	(1.855)	(2.997)
Observations	4460		4460		2478	
Zero Observations	3543		3543		1910	
Log likelihood	-2335.26		-2341.71		-1308.27	
Vuong test	8.16		8.13		7.13	

Notes: Dependent variable: Conflict prevalence; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1; ldg = largest discriminated ethnic group, phi = positive horizontal inequality (relative gap between mean national income and income level of the richest group), nhi = negative horizontal inequality (relative gap between mean national income and income level of the poorest group)

Table A.15: Additional Results of ZIP Model: Varying in Income and Democracy

	(1)		(2)		(3)	
	ZIP		ZIP		ZIP	
	Outcome	Inflation	Outcome	Inflation	Outcome	Inflation
Opportunity						
log real GDP					-0.066*	0.403**
					(0.032)	(0.056)
RGDPPC Growth					-2.262**	0.774
					(0.457)	(0.822)
Pri Exports/GDP	-2.212**		-1.838**		-1.605*	
	(0.667)		(0.686)		(0.739)	
Pri Exports/GDP^2	1.958		1.618		1.522	
	(1.129)		(1.147)		(1.253)	
Urbanisation Rate	-0.103*	1.217**				
	(0.049)	(0.242)				
Life Expectancy			-0.887**	1.861**		
			(0.233)	(0.575)		
ΔLife Expectancy			-7.353**	8.988		
			(2.280)	(6.213)		
log % Mountains	0.048*		0.075**		0.079**	
	(0.029)		(0.024)		(0.026)	
Grievance						
Polity Index	0.034**	0.277**	0.032**	0.102**		
	(0.006)	(0.058)	(0.007)	(0.028)		
Polity Index^2	-0.006**		-0.008**			
	(0.001)		(0.001)			
Democracy					-0.420**	1.123**
					(0.099)	(0.186)
Eth Frac (F&L)	5.702**	0.253	6.011**	1.116**	5.859**	1.346**

Continued on next page

Table A.15 – *Continued from previous page*

	(1)		(2)		(3)	
	ZIP		ZIP		ZIP	
	Outcome	Inflation	Outcome	Inflation	Outcome	Inflation
	(0.658)	(0.472)	(0.669)	(0.403)	(0.733)	(0.372)
Eth Frac^2 (F&L)	-4.570**		-4.710**		-4.526**	
	(0.593)		(0.603)		(0.674)	
ldg	1.134**	-17.76**	0.767*	-11.63**	0.476**	-12.89**
	(0.139)	(2.687)	(0.187)	(2.006)	(0.181)	(1.645)
phi	-0.199*	1.153**	-0.186*	0.717**	-0.178*	0.575**
	(0.077)	(0.167)	(0.081)	(0.089)	(0.081)	(0.075)
nhi	0.185**	-0.652*	0.207**	-0.439†	0.203**	-0.773**
	(0.064)	(0.268)	(0.074)	(0.283)	(0.072)	(0.242)
Controls						
log Population	0.093**	-0.703**	0.031	-0.642**	0.072	-0.967**
	(0.294)	(0.085)	(0.032)	(0.089)	(0.046)	(0.077)
Cold War	-0.197**		-0.239**		-0.222**	
	(0.064)		(0.072)		(0.068)	
Africa	0.057		-0.066		0.200*	
	(0.083)		(0.088)		(0.095)	
Constant	-3.802**	4.673**	0.574	1.667	-2.647**	5.228**
	(0.549)	(1.350)	(1.048)	(2.327)	(0.701)	(0.865)
Observations	5083		4998		4446	
Zero Observations	4018		3945		3528	
Log likelihood	-2775.87		-2730.70		-2342.33	
Vuong test	9.47		7.97		8.46	

Notes: Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1; ldg = largest discriminated ethnic group, phi = positive horizontal inequality (relative gap between mean national income and income level of the richest group), nhi = negative horizontal inequality (relative gap between mean national income and income level of the poorest group)