Contingencies in Economic Growth and Development: An Empirical Investigation of Potential Sources of Exogenous Variation

Vusal Musayev

In partial fulfilment of the requirement for the degree of Doctor of Philosophy in Economics

University of London, Royal Holloway

Declaration of Authorship

I, Vusal Musayev, hereby declare that this thesis and the work presented in it is entirely my own.

To my family, for their patience and support.

Abstract

This thesis builds on the recent developments in methods of panel estimation to investigate four questions in the economics of growth and development, concentrating on the effects of three variables of interest – ad-valorem tariff rates, military expenditure shares and natural resource windfalls. Particularly, in the light of endogeneity concerns, the analysis employs the generalized method of moments (GMM) framework to investigate whether the effects of all three variables of interest are heterogeneous across the income distribution, i.e. contingent on a country's economic development level, and what are the potential sources of exogenous variation for externalities that might drive this heterogeneity leading to contradicting outcomes found in the literature.

The first chapter examines the effects of tariff rates on indicators of long-run development by analysing the effects of ad-valorem tariffs on fertility rates, life expectancy, infant mortality and education contingent on income levels. The analysis confirms previous findings of a differential effect of tariffs on economic growth, suggesting a detrimental impact of trade limitations for high income level countries, but not for low income level economies. In addition, the investigation contributes to the literature showing that for high income economies, tariffs are harmful not only for economic growth, but also for long-run development. However, these effects are less clear for lower income economies. In particular, for developing countries there is a paucity of evidence for the effects of tariffs on indicators of long-run development. The investigation also attempts to identify the channels through which tariffs might affect the economic growth and development indicators for lower income economies, the results suggesting infrastructure as a potential driver.

The second chapter clarifies the ambiguous results found in the military spending and economic growth literature, where the impact of military expenditure is frequently found to be non-significant or negative. The investigation examines the effects of military spending on growth by analysing this relationship contingent on initial income per capita using a large dataset on military expenditure. The findings reveal that while growth falls with higher levels of military spending, the marginal impact of military spending is increasing in initial income levels. In contrast to previous findings from the literature, this increase is consistent across different

income groups and type of economies, and is monotonic in direction, going towards zero for sufficiently high income level countries.

The third chapter examines the potential sources of externalities for the relationship between economic growth and military spending using a large panel dataset on military spending and variety of conflict measures. The investigation reproduces many of the results of the existing literature and provides a new analysis on the relationship between conflict, corruption, natural resources and military expenditure and their direct and indirect effects on economic growth. The analysis finds that the impact of military expenditure on growth is generally negative as found in the literature, but that it is not significantly detrimental for countries facing either higher internal or external threats, and for countries with large natural resource wealth, once corruption levels are accounted for.

The fourth chapter empirically investigates the relationships between resource windfalls, political regimes, conflict and growth employing a distinctive commodity price shock measurement. The analysis clarifies the potential mechanism behind the ambiguous outcomes of the existing resource literature, particularly showing that resource windfalls have significant effects on conflict only in politically unstable autocracies, where these effects are heterogeneous in the response, conditional on a country's initial political violence level. The findings also demonstrate that resource shocks are positively associated with economic performance in democracies and in politically stable autocracies, while reducing growth for unstable autocracies.

Table of Contents

List of Tables

List of Figures

Acknowledgements

I am indebted to University of London, Royal Holloway for the financial support they have provided me with throughout my doctoral studies. I would also like to express my gratitude to Andrew Mountford for helpful comments and suggestions throughout.

1. Introduction

The recent developments in panel estimation methods have enabled economists to shed new light on economic growth. This thesis applies these developments to investigate four questions in the economics of growth and development concentrating on the effects of three variables of interest – ad-valorem tariff rates, military expenditure shares and natural resource windfalls. In particular, the analysis employs the generalized method of moments (GMM) framework to overcome the shortcomings, such as inconsistency and endogeneity, experienced when using many of the other panel estimators that have been employed in the literature. The endogeneity issue is of particular concern for the investigation in this thesis, considering the results indicate that the effects on growth from all three variables of interest are heterogeneous across the income distribution, i.e. contingent on a country's economic development level, implying that there may be other factors which might drive this heterogeneity leading to contradicting results as found in the literature. Therefore it is of importance to investigate the potential sources of exogenous variation for externalities that might generate this heterogeneity.

How do the changes in the variables of interest affect a country's economic growth and development level? And what factors drive heterogeneous outcomes for these relationships? These are the key important questions that this thesis attempts to address which are particularly interesting from a policy perspective, since for the variables of interest to be associated with long-run improvement, no matter whether this improvement is represented by income growth or development in health, education, socioeconomic and political stability or institutional quality, it is necessary that income inflows generated by the changes in the variables under consideration are spent productively and not frittered away, and hence the investigation of the channels which induce these heterogeneous outcomes is required.

Beyond the findings of the analysis, the thesis also makes an exceptional data contribution by providing the literature with a large dataset on military expenditure and a distinctive measurement for commodity price shocks. In particular, since online data tables for military spending are only available from the period 1988 and onwards, military expenditure shares for the previous periods have been collected and manually inputted directly from the SIPRI (Stockholm International Peace Research Institute) Yearbooks enabling the investigation to employ, to the best of my knowledge, a dataset with the largest coverage period in the current defence literature. Additionally, in the light of endogeneity concerns associated with the measurements of natural resource abundance which have been previously employed in the literature, a country-specific geometrically weighted index of commodity net export prices is constructed facilitating the clarification of ambiguous outcomes in the resource literature.

The first chapter empirically examines the effects of tariff rates on indicators of long-run development by analysing the effects of ad-valorem tariffs on fertility rates, life expectancy, infant mortality and education contingent on income levels. The analysis confirms previous findings of a differential effect of tariffs on economic growth, suggesting a detrimental impact of trade limitations for high income level countries, but not for low income level economies. In addition, the investigation contributes to the literature showing that for high income economies, tariffs are harmful not only for economic growth, but also for long-run development. However, these effects are less clear for lower income economies. In particular, for developing countries there is a paucity of evidence for the effects of tariffs on indicators of long-run development. The investigation also attempts to identify the channels through which tariffs might affect economic growth and development indicators for lower income economies, the results suggesting infrastructure as a potential driver. This chapter has been re-submitted to the *OECD Journal: Economic Studies*.

The second chapter clarifies the ambiguous results found in the military spending and economic growth literature, where the impact of military expenditure on growth is frequently found to be non-significant or negative. The investigation examines effects of military spending on growth by analysing this relationship contingent on initial income per capita using a large dataset on military expenditure. The findings reveal that while growth falls with higher levels of military spending, the marginal impact of military expenditure is increasing in initial income levels. In contrast to previous findings from the literature, this increase is consistent across different income groups and type of economies, and is monotonic in direction going towards zero for sufficiently high income level countries. This chapter has been submitted to the *Oxford Bulletin of Economics and Statistics*.

The third chapter examines the potential sources of externalities for the relationship between military spending and economic growth using a large panel dataset on military spending and variety of conflict measures. The investigation reproduces many of the results of the existing literature and provides a new analysis on the relationship between conflict, corruption, natural resources and military expenditure and their direct and indirect effects on economic growth. The analysis finds that the impact of military expenditure on growth is generally negative as found in the existing literature, but that it is not significantly detrimental for countries facing either higher internal or external threats, and for countries with large natural resource wealth, once corruption levels are accounted for. This chapter is published in the journal of *Defence and Peace Economics*.

The fourth chapter empirically investigates the relationships between resource windfalls, political regimes, conflict and growth using a distinctive commodity price shock measurement. The analysis clarifies the potential mechanism behind the ambiguous outcomes of the existing resource literature, particularly showing that resource windfalls have significant effects on conflict only in politically unstable autocracies, where these effects are heterogeneous in the response, conditional on a country's initial political violence level. Investigation of how these relationships are reflected onto the economic growth reveals that, resource windfalls are positively associated with growth in democracies and in politically stable autocracies. In contrast, an increase in resource windfalls reduces growth for politically unstable autocracies. This chapter has been submitted to the *Journal of Development Economics*.

2. Are Tariffs Good for Development?

2.1. Introduction

The effect of tariffs on the growth prospects of lower income economies is a perennially important topic in the development economics literature. How does international trade or limitations to trade affect a country's economic growth? And how do these changes generated by barriers to trade reflect on an economy's development level? These are important questions, as the effects of tariffs may just represent short-run gains or losses which do not feed into future development.

While a large body of research in economic literature concentrates on the investigation of the links between development and international trade as a proxy for the openness of the economy, investigation of the relationships between long-run development indicators with the most direct measures of openness such as tariff rates as a trade policy tool has received much less attention. As the effects of income changes generated by trade barriers cannot be referred as generic income changes, for tariffs to be advocated as a development tool it is necessary to show that tariffs are associated with long-run improvement in an economy's development, i.e. the additional revenues from tariffs are being spent productively and not frittered away.

Therefore, in order to motivate the empirical analysis and facilitate the interpretation of the results, the paper opens the discussion, firstly, by replicating the DeJong and Ripoll (2006) results which demonstrate that although tariff rates have a significant negative association with growth in high income economies, this association for low income economies is positive. Given these findings, the analysis then concentrates on the investigation of how additional income revenues (losses) generated by change in tariff rates for low (high) income economies are transferred onto the indicators associated with long-run development such as the fertility rate, life expectancy, infant mortality and education, conditional on everything else in the economy being constant (including generic income level of the economy).

The analysis finds that while tariffs do have detrimental impacts on economic growth and long-run development indicators for higher income economies, as would be suggested by standard neoclassical theory, for lower income economies the effects of tariffs on development indicators are less clear. These results therefore confirm the findings of a differential effect of tariff rates on economic growth for high and low income economies, but in fact find little evidence of the effects of tariff rates on the indicators of long-run development in lower income economies. In addition, the investigation also attempts to find a mechanism through which tariff rates might affect economic growth and development indicators for lower income economies. The results suggest infrastructure as one of the potential channels that might drive the effect of tariffs.

The remainder of the paper is organized as follows. The next section reviews the related literature regarding the impact of international trade on economic growth and development with a brief discussion of how income changes are associated with long-run development indicators across income distribution. Section 2.2 reviews the data and methodology used during the analysis. Section 2.3 presents the estimation results and Section 2.4 concludes.

2.1.1. Related Literature

While a large body of empirical research based on cross-country analysis has generally found a positive relationship between trade openness and growth (see e.g., Dollar, 1992; Ben-David, 1993; Lee, 1993; Sachs and Warner, 1995; Harrison, 1996; Edwards 1998; Frankel and Romer, 1999; Wacziarg, 2001), recent empirical studies have found that this effect may be asymmetric depending on a country's level of development.[1] The literature investigating this contingency provides evidence that tariffs have the potential to improve developing economies' growth prospects.[2] In

[1] The findings of positive relationship between trade openness and growth support the view that the limitations on trade have only detrimental impact on economies' growth prospects. However, the empirical validity of the evidence from this literature has been criticized by Rodriguez and Rodrik (2001), who argued that for the most part, the results in this literature are driven either by methodological problems with the empirical strategies, or by application of poor measures of openness that are highly correlated with other sources of bad economic performance, such as policy or institutional variables that have an independent damaging effect on growth.

[2] A variety of theoretical and empirical models in the literature of comparative advantage considered the potential presence of a contingent relationship between trade and economic growth (see e.g., Findlay and Kierzkowski, 1983; Lucas, 1988; Stokey, 1991; Young, 1991; Grossman and Helpman, 1991; Matsuyama, 1992; Atkeson and Kehoe, 2000). The presumption in these models (endogenous growth, skill-acquisition or learning-by-doing and other forms of endogenous technological change), is that lower trade limitations enhance output growth in the world as a whole. However a subset of economies may experience reduced growth depending on countries' initial factor endowments and levels of technological development (see e.g., Aghion and Howitt, 2005; Acemoglu *et al.*, 2006). And as emphasized by Grossman and Helpman (1991), the general answer to the question whether trade

particular, DeJong and Ripoll (2006) find significant differential effects of tariffs and economic growth relationship between high and low income economies.

Although the asymmetric role of international trade on growth across nations is increasingly viewed as a stylized fact in growth and development economics, the explanations of the source of this evidence are mixed. In contrast to the literature on the dynamics of comparative advantage, there is an alternative literature focusing on the interaction between population growth and comparative advantage as a potential trigger that causes "Great Divergence" in income per capita between less developed and developed countries (Deardorff, 1994; Galor and Weil, 1999, 2000); and generates differential impact of trade on economic development.[3] In particular, recent contributions by Galor and Mountford (2006, 2008) suggest that in developed countries the gains from trade have been directed towards investment in education and growth in income per capita by concentrating in the production of industrial, skilled intensive goods; whereas a significant portion of gains from trade for less developed economies have been channelled towards population growth, namely fertility decisions, and utilized primarily for a further increase in the size of the population, rather than the income of the existing population, since the absence of significant demand for human capital provides limited incentives to invest in the quality of the population (see also Doces, 2011).[4]

---

encourage innovation in a small open economy is it depends. In particular, it depends on whether the comparative advantage forces the economy's resources in the direction of activities that induce long-run growth or divert them from such activities.

[3] The origin of "Great Divergence" in living standards across countries has been discussed by many scholars. Selected contributions include the following works. On institutional factors, refer to Easterly and Levine (2003), Rodrik *et al.* (2004), Acemoglu *et al.* (2005), Ashraf and Galor (2007). With respect to geographical factors, refer to Krugman and Venables (1995), Diamond (1997), Gallup *et al.* (1999), Baldwin *et al.* (2001) among others. Considering the role of human capital formation, refer to Galor and Weil (2000), Galor and Moav (2002), McDermott (2002), Doepke (2004), Glaeser (2004), Galor (2005), Galor et al. (2006) and others.

[4] Specifically, Galor and Mountford (2008) show that trade asymmetrically affects a country's population development by reducing fertility and increasing education for developed countries; whereas the reverse is the case for the less developed countries. Stratifying a country's export share into manufacturing and primary sectors, Gries and Grundmann (2012) demonstrate that manufacturing exports lower fertility levels, while primary exports have either a positive impact or none at all. Among other theoretical contributions that link trade and fertility, see also Lehmijoki and Palokangas (2009) which focuses on wage and income effects induced by international trade; and Saure and Zoaby (2011) that concentrates on female labour force participation in connection with international trade.

Previous research on the effect of income on health outcomes and contrasting trends in cross-sectional health inequality that have occurred during the last half of the twentieth century, namely convergence in life expectancy averages and divergence in infant mortality rates suggest that the impact of economic growth does not tend to be uniform across all measures of well-being or samples. For example, Pritchett and Summers (1996) show that poor countries had been outperforming rich countries in improving life expectancy, but lagging behind in their reduction of infant mortality; suggesting that the link between economic development and life expectancy may be stronger among poorer nations, whereas this link with infant mortality may be stronger among wealthier nations.[5]

Focussing on the impact of international trade on health outcomes, Owen and Wu (2007) find that increased openness lowers the rate of infant mortality and increases life expectancy, especially in developing countries, suggesting that some of the positive correlation between trade and health can be attributed to knowledge spillovers. Considering the influence of geographical factors, Jamison *et al.* (2001) suggest that more open countries have a faster rate of technical progress that improves infant mortality outcomes.[6]

The importance of infrastructure for international trade is widely documented in the literature.[7] Looking for the answer to the question why less developed countries

---

[5] Investigating the relationship between economic activity and health status, Pritchett and Summers (1996) show that wealthier economies have lower infant mortality rates and higher life expectancy. Their results also show that the wealthiest two quartiles of countries increased their life expectancy by lower rates, but reduced their infant mortality by higher rates, than the poorest two quartiles during the sample period. In addition, using the sample of less developed countries, Brady *et al.* (2007) demonstrate a positive income effect on life expectancy, whereas this link is not significantly different from zero for infant or child survival. This might affect the relationship between health outcomes and income shocks generated by tariff rates.

[6] Rodrik *et al.* (2004), in an effort to sort out the geographical, institutional, and trade related determinants of development, suggest that trade and institutional features of the economy may evolve endogenously, with trade having positive effect on the quality of institutions; which themselves may create a policy environment that is conducive to improved health (see also Bhagwati, 1998). Investigating the partial effects of trade and institutions on growth in the long run, Dollar and Kraay (2002) find that both trade and institutions are important joint determinants, but trade has a relatively stronger role in the short run (see also Alcala and Ciccone, 2004). For the investigation of the relationship between economic growth and health, see also Bhargava *et al.* (2001) who demonstrate that countries with better health outcomes grow faster.

[7] Depending on geography and endowments of a country, Bougheas *et al.* (1999) estimate the augmented gravity model of bilateral trade flows of countries for which investment in infrastructure is optimal; and find a positive relationship between infrastructure and volume of trade. Limao and

trade less relative to other countries, Francois and Manchin (2013) highlight the role of infrastructure demonstrating that for trade the dependence on institutional quality and access to well developed infrastructure is far more important than variations in trade policy limitations. This implies that policy emphasis on developing country market access, instead of support for trade facilitation, may be misplaced.

The remainder of the paper is organized as follows. Section 2.2 reviews the data and methodology used during the analysis. Section 2.3 presents the estimation results and Section 2.4 concludes.

2.2.1. Data and Descriptive Statistics

The analysis is based on a balanced panel data set that consists of 70 countries over the 1975-2000 period.[8] The dependent variable for the tariffs and economic growth analysis is logged per capita real (Laspeyres) GDP collected from the Penn World Table (PWT 6.3). The log of initial income per capita is used as regressor (e.g., logged income per capita measured in 1975 serves as an explanatory variable when log of income per capita measured in 1980 is the dependent variable).

As a trade-barrier indicator, the analysis employs ad-valorem tariffs, measured using import duties as a percentage of imports since it provides superior ranking for countries according to their levels of openness (Rodriguez and Rodrik, 2001).

Human capital proxies used in the analysis as explanatory variables are the average years of secondary schooling for males and females over 15 years of age from the Barro and Lee dataset. Additionally, for the investigation of the tariffs and education relationship, the analysis employs current gross primary school-enrolment ratios by gender (the number of children enrolled at each level divided by the population of

---

Venables (2001) estimate that a deterioration of infrastructure from the median to the 75th percentile raises transport costs by 12% and reduces trade volumes by 28%. For the role that quality of infrastructure has on a country's trade performance, see also Nordas and Piermartini (2009), Wilson *et al.* (2005).

[8] A sample of 70 countries is selected for which data on tariffs are available. The sample size decreases to 68 countries when the tariffs and education relationship is investigated. To be able to compare the estimation results with the DeJong and Ripoll (2006) results, a sample of 60 countries is used to explore the effect of tariffs on economic growth. In addition, the investigation of the link between tariffs and infrastructure is based on a 44 countries data set that cover 1990-2000 period since the paved road data, a proxy for infrastructure, is available only after the 1990s. See Appendix Tables 2-B and 2-C for the list of countries and descriptive statistics.

persons of the designated school age) from the World Bank as the dependent variables, and the average years of secondary schooling for males and females over 25 years of age as explanatory variables following Barro and Lee (1994).[9] As indicators of long-run development, the investigation also utilises the log of fertility, log of life expectancy and log of infant mortality, as reported by the United Nations, where all are measured as averages over the half-decade.

Real private investment and real government expenditures, each measured as a share of real GDP, are also included in the models, where the data are taken from the Penn World Table (PWT 6.3). As a proxy to infrastructure, the analysis employs the World Bank data on paved roads, measured as a percentage of total roads, widely used in the literature (see e.g., Nordas and Piermartini, 2009; Francois and Manchin, 2013).

To capture potential contingencies in the relationship between tariffs and income, the specifications include additional interaction terms constructed in two ways: first, the product of logged initial income and tariffs; second, the product of tariffs and 1975 income rankings (which takes values 1 for the poorest income countries to 4 for the richest countries). Income rankings are constructed as in DeJong and Ripoll (2006) using the classification of the World Development Indicators by the World Bank where four income groups are defined as high-income (rank 4) countries; upper-middle-income (rank 3) countries; lower-middle-income (rank 2) countries; and low-income (rank 1) countries.[10]

Table 2-1 and 2-2 provide descriptive statistics for average tariff rates, economic growth, development indicators and infrastructure over different income groups. Three aspects of these statistics are of particular interest in the analysis. The first is

[9] The enrolment ratios reported by the World Bank can exceed 100% because of repeaters and other attendees whose age falls outside of the designated range for the schooling. Therefore, the analysis truncates all values that were reported above 100% to 100%. The school-attainment variables of average years of secondary schooling by gender over 25 years of age can be interpreted in terms of the impact of parental schooling on children's choices of schooling.

[10] The cut-off levels of income rankings are taken as in DeJong and Ripoll (2006), where country classifications are obtained by mapping classification thresholds as defined by the World Bank's income measures into the corresponding Penn World income measures. The resulting definitions are as follows: high-income level countries are those with real per capita GDP above $11,500; upper-middle income level countries those between $5,500 and $11,499; lower-middle income level countries are between $2,650 and $5,499; and low-income level countries those with less than $2,650. All classifications are based on 1975 income rankings.

the tendency that relatively richer countries enjoy relatively rapid growth. Average growth rates increase when moving from the lower to higher income classifications: from 1.07% (s.d. 2.89) for low-income countries to 1.87% (s.d. 0.76) for high-income countries. The second aspect of these statistics is that relatively poor countries tend to impose relatively high tariff barriers. The average tariff rates tend to decrease monotonically between high and low income classifications: from 16.99% (s.d. 6.59) to 2.91% (s.d. 3.33). The third feature is that development indicators and the infrastructure measure of paved roads respond to the movements across income classifications monotonically according to their correlations with income.[11] In particular, average fertility and infant mortality rates tend to decrease, while life expectancy, education, and infrastructure tend to increase monotonically when moving from the lower to higher income classifications.

2.2.2. Empirical Methodology

As is now standard in the literature, a panel data set is constructed by transforming the time series data into non-overlapping half decades. This filters out business cycle fluctuations, so that the analysis can focus on the long-run effects rather than the short-run gains (Aghion *et al.*, 2009). Firstly, discussion concentrates on the method that is used to explore potential contingencies in how tariff rates affect economic growth. Then discussion turns into the influence of tariffs on the main determinants of economic growth such as fertility, life expectancy, infant mortality and education through income. The main interest behind the estimated model is to see whether tariff rates affect long-run determinants of economic growth, or whether they provide a short-run gain, that can benefit a country when it is targeted to balance economic situation just for a short time period such as a budget deficit. As an estimation approach, the analysis employs the System GMM dynamic panel estimator by Arellano and Bover (1995) and Blundell and Bond (1998), which builds on the GMM Difference estimator developed by Arellano and Bond (1991).[12] This

[11] For correlations between the variables of interest, see Appendix Table 2-D.

[12] Because of the limited scope in paved road data, OLS estimation results for tariffs and infrastructure relationship are also reported as a comparison with GMM results. Moreover, stratifying the sample into income ranks for tariffs and growth relationship severely reduces number of observations during the estimation process. Thus, the analysis also reports OLS estimation results for comparison purposes.

approach addresses the issues of joint endogeneity of all explanatory variables in a dynamic formulation and of potential biases induced by country-specific effects.[13]

During the estimation process, the non-linear effect of tariffs is captured using two approaches. Under the first, the analysis includes a quadratic in tariffs and all explanatory variables into the estimation model following Barro and Lee (1994). The second approach employs interaction term of tariff rates with real per capita income level or ranking where the analysis follows DeJong and Ripoll (2006).

Letting the subscripts i and t represent country and time period respectively, the estimated model that is introduced with interaction term can be written as

$$y_{it} = \lambda \, GDP_{i(t-1)} + \theta_1 TAR_{i(t-1)} + \theta_2 TAR_{i(t-1)} * INC_{i(t-1)} + \beta' Z_{i(t-1)} + \mu_t + \xi_i + \varepsilon_{it} \quad (2i)$$

where y_{it} is either the log of real GDP per capita income level, the gross school-enrolment ratio, paved road ratio; the log of fertility, the log of life expectancy or the log of infant mortality, $GDP_{i(t-1)}$ is a log of initial real per capita income, $TAR_{i(t-1)}$ is initial realization of ad-valorem tariffs, INC is either logged initial real per capita income or 1975 income rankings, $Z_{i(t-1)}$ is a vector of control variables, μ_t is a period-specific constant, ξ_i is an unobserved country-specific effect, and ε_{it} is an error term.[14]

The hypothesis for the relationship between tariffs and economic growth is that $\theta_1 > 0$ and $\theta_2 < 0$ implying that the impact of tariffs, $\theta_1 + \theta_2 * INC_{i(t-1)}$, is more negative at high levels of income. Moreover, when θ_1 and θ_2 have opposite signs, a threshold effect arises.[15]

---

[13] For detailed information regarding the assumptions employed when using GMM estimators, see Appendix 2-A.

[14] For the estimation of potential contingencies between tariffs and growth, the baseline approach (2i) takes the form:

$$GDP_{it} - GDP_{i(t-1)} = \alpha \, GDP_{i(t-1)} + \theta_1 TAR_{i(t-1)} + \theta_2 TAR_{i(t-1)} * INC_{i(t-1)} + \beta' Z_{i(t-1)} + \mu_t + \xi_i + \varepsilon_{it}$$

where GDP is log of real income per capita level. Equation above then can be written as:

$$GDP_{it} = (1+\alpha) \, GDP_{i(t-1)} + \theta_1 TAR_{i(t-1)} + \theta_2 TAR_{i(t-1)} * INC_{i(t-1)} + \beta' Z_{i(t-1)} + \mu_t + \xi_i + \varepsilon_{it}$$

Therefore the coefficient of log of initial income per capita has to be interpreted as $\lambda = 1+\alpha$.

[15] Letting γ_1 and γ_2 be, respectively, the coefficients for tariffs and its square term as specified under the first approach, the threshold level for tariffs can be calculated by taking the first derivative with respect to tariffs. A threshold effect arises when γ_1 and γ_2 have opposite signs:

$$\frac{\delta \, y_{it}}{\delta \, TAR_{i(t-1)}} = \gamma_1 + 2 \gamma_2 * TAR_{i(t-1)} > 0 \ \xrightarrow{yields} \ TAR_{i(t-1)} > \widetilde{TAR} := -\frac{\gamma 1}{2\gamma 2}$$

$$\frac{\delta y_{it}}{\delta\, TAR_{i(t-1)}} = \theta_1 + \theta_2 * INC_{i(t-1)} > 0 \xrightarrow{yields} INC_{i(t-1)} > \widetilde{INC} := -\frac{\theta 1}{\theta 2}$$

The standard errors of the respective threshold levels for both approaches are computed using the delta method. However, it is of note that in small samples, the delta method is known to result in excessively large standard errors.

For the relationship between tariffs and indicators of long-run development, the hypothesis is that the signs of θ_1 and θ_2 are determined by the correlation between real per capita income and development indicators such that tariffs can have impact through income.

Selection of long-run development indicators and explanatory variables for all specifications considered follows Barro and Lee (1994). The analysis also stratifies countries into different income groups, based on initial income levels, and estimates separate specifications of (2i) that are linear in tariffs.

As an additional sensitivity check, outliers are singled out using a strategy advocated by Belsley *et al.* (1980) that involves the application of the DFITS statistic to find out the countries associated with high combinations of residual and leverage statistics. Moreover, to ensure that the estimated effect is not driven by the number of instruments, the investigation employs the "1 lag restriction" technique following Roodman (2009) that uses only certain lags instead of all available lags as instruments. The treatment of each regressor according to their exogeneity levels is based on upper and lower bound conditions (Roodman, 2006).[16]

Along with coefficient estimates obtained using the System GMM estimator, tables also report three tests of the validity of identifying assumptions: Hansen's (1982) test of over-identifying restrictions for the joint validity of moment conditions;[17] Arellano and Bond's (1991) AR(1) and AR(2) tests in first differences. The AR(1) test is of the null hypothesis of no first-order serial correlation, which can be rejected under the identifying assumption that ε_{it} is not serially correlated; and the AR(2) test is of the null hypothesis of no second-order serial correlation, which should not be

[16] For detailed information regarding upper and lower bound conditions, see Appendix 2-A.
[17] It is of note that some of the Hansen test statistics during the analysis (especially when the investigation stratifies the data set into separate subsamples) yield high p-values (e.g., in excess of 0.90). This can be a warning signal that too many moment conditions are in use; and therefore, the results from these specifications must be read with caution.

rejected. In addition, to control for heteroskedasticity, the Windmeijer (2005) small-sample correction is applied.

2.3. Estimation Results

Table 2-3 reports the estimation results obtained from the tariffs and economic growth analysis. Part 1 investigates this relationship first non-linearly employing the interaction terms, and then linearly by stratifying countries into low-half and high-half income subsamples. Part 2 examines the linear association of this relationship for each income rank.

The investigation of how the effect induced by tariffs on economic growth is transfered onto long-run growth determinants is presented in Tables 2-4 – 2-7. Table 2-4 estimates the non-linear relationship between tariffs and fertility rates first using the quadratic and then interaction term specification. This link is also examined for low-half and high-half income subsamples where fertility is linearly related with tariffs. The same approach is applied for the analysis of tariff rates with life expectancy, infant mortality and education where the results are reported, respectively, in Tables 2-5, 2-6 and 2-7.

Table 2-8 explores the effects of tariff rates on infrastructure as a potential channel through which tariffs can affect growth and development for low income economies.

2.3.1. Tariffs and Growth

Figure 2-1 presents a simple illustration how the relationships between tariffs and economic growth depend on the level of income. The upper graphs consider the relationship between growth and two tariffs-initial income interaction terms (logged initial income and the World Bank's income ranking indicator), while the lower graphs explore this link for different subsamples where growth and tariffs are related linearly. In each case, the residuals of a growth regression on a set of variables are compared with the residuals of tariffs (either interacted or linear) regression on the same variables.[18] This produces adjusted measures of tariffs which are purged from

[18] Partial regression estimates are obtained in two stages. First, both the dependent variable and the isolated independent variable are projected onto the additional set of regressors under consideration. Next, the residuals of the dependent variable are regressed against the residuals of the independent variable. The figures are produced using OLS regressions.

any collinearity with the standard growth determinants. The upper graphs illustrate clearly a negative significant relationship between growth and tariffs for economically developed countries. This fact is supported by the lower graphs where this relationship is negative for the high-income subsample and positive for the low-income group.

The estimation results for the growth and tariffs analysis are illustrated in Table 2-3. Part 1 examines this relationship with introduction of both tariffs/income level and tariffs/income ranking interaction terms. Tariffs and interaction terms enter significantly taking the expected signs. Combining these two terms enables the identification of a threshold of initial income per capita level above (below) which a higher level of protectionism dampens (increases) economic growth. The point estimates of threshold levels are close to the cut-off level used to stratify the countries into high and low income groups. Stratifying countries into low-half and high-half income subsamples illustrates, respectively, positive and negative significant impact of tariffs on economic growth.[19] Regarding quantitative significance, the impact on growth of a 10-percentage-point increase in tariffs is estimated as 1.2 percentage points among the low-half income countries, and −1.8 percentage points among high-half income countries.[20]

Part 2 of Table 2-3 runs the same exercise for the four income ranks. In all cases, tariffs enter positively for the poorest and lower-middle income countries, while this effect is negative for higher-middle and the richest income group. For all income groups, except for income rank 2 countries, tariffs generally illustrate a significant impact on growth, implying that the estimated effect of tariffs for the low-half income subsample is mainly driven by the poorest countries. Application of additional sensitivity restrictions mostly does not alter the significance of the

---

[19] All estimates reported in Part 1 of Table 2-3 are achieved using the "1 lag restriction" technique following Roodman (2009). When all available lags are employed, the coefficient estimates of tariffs are 0.004 for low-half subsample, and -0.007 for high-half subsample. These estimates are, respectively, 0.005 and -0.011 when outliers are eliminated from these subsamples. Note that DeJong and Ripoll's (2006) estimates obtained excluding outlier countries are, respectively, 0.004 and -0.011; which are almost the same with the estimates here when the same specifications are used.

[20] These measures are obtained by multiplying the coefficient estimate by the percentage-point change of 10, dividing by the time span between income observations (5 years), and then multiplying by 100 to convert to a percentage-point measurement.

estimates.[21] Regarding quantitative significance, using the estimates produced by the OLS (GMM) estimator, the impact on growth of a 10-percentage-point increase in tariffs is estimated as 1.2 (1.4) percentage points among the poorest countries, and -1.8 (-2.4) percentage points among the richest countries.

2.3.2. Tariffs and Long-Run Development

The hypothesis regarding the determinants of long-run growth is that the signs of θ_1 and θ_2 in the baseline specification (2i) is determined by the correlation between real per capita income and the variables under interest, such that tariffs can have impact through income. For instance, since the marginal impact of tariff rates on economic growth is declining in initial income, then taking into account negative correlation between fertility and income, tariff rates are expected to increase fertility when the income level of an economy is increasing. Alternatively, the impact of tariffs on fertility should be negative for low-half subsample, and positive for high-half subsample. The same intuition is applied for interaction term specifications of tariffs contingency on life expectancy, infant mortality, and education.

The signs of linear and non-linear terms of tariffs when employing the quadratic term specification are expected to be the reverse of that of the interaction term specification. A simple explanation is that the square term for tariff rates captures the impact of high trade limitations, where interaction term explains the effect of limitations to trade while the income level of an economy is increasing. The reverse signs are expected, due to the fact that countries tend to apply relatively lower tariff rates as an economy becomes richer (see Table 2-1). For instance, the linear tariffs term captures the effect of the appication of relatively lower trade limitations tend to be applied by relatively richer economies. Since tariffs decrease income for higher income level countries, the impact of the linear tariffs term on fertility is expected to be positive. The quadratic tariffs term in turn captures the effect of the application of relatively higher barriers to trade tend to be implemented by relatively poorer economies. As the application of tariffs increases income for lower income level economies, the quadratic term should decrease fertility. For both linear and quadratic cases, the negative correlation between fertility and income is considered. Therefore,

[21] The significance of tariffs estimates for upper-middle income subsample exhibits sensitivity across specifications. However, it is of note that the magnitude of estimates is lying within one standard deviation with the high-half income group estimates.

the signs of the linear and square tariff terms are expected to be the identical with the fertility case for infant mortality; and opposite for life expectancy and education since these indicators are positively correlated with income. Also note that for linear and quadratic terms of income, the signs are expected to be reverse of that of tariff terms.

2.3.2.1. Tariffs and Fertility

A simple illustration of how the impact of income on fertility rates changes with the income level of a country is presented in Figure 2-2. The plots illustrate a significant negative income effect on fertility when income rank 4 countries are excluded from the sample, while this effect is positive and not significantly different from zero for the richest economies.[22] The implication of this relationship can be explained with the increased value of time of parents, a substitution of quality of children for quantity as income increases, where for the highest income level countries the effect of income on fertility is nil.

The estimation results for the fertility and tariffs analysis are reported in Table 2-4.[23] Linear income terms enter negatively, while square terms demonstrate positive association with fertility, supporting the findings from Figure 2-2. In all cases, the estimates of the impact of both linear and non-linear tariff rates on fertility take the expected signs. The estimated non-linear impact of tariffs is always significant. The linear tariffs term loses its significance when it is interacted with the World Bank's income ranking index, while shows strong quantitative impact when the interaction term with logged initial income and its quadratic term are employed.

The coefficient estimates of the tariffs and interaction terms take, respectively, negative and positive signs implying that the more developed an economy is, the higher is the point estimate of the impact of tariffs on fertility. The point estimates of

[22] While not reported separately, partial estimation results for low-half subsample demonstrate a significant negative impact of income on fertility, while for high-half subsample the negative impact of income is mainly driven by income rank 3 countries.

[23] The investigation under "Barro-Lee specification" in Table 2-4 allows fertility to respond non-linearly to the values of the real investment ratio and the ratio of government expenditure to GDP. However, the original Barro and Lee (1994) specification does not include these variables, while along with initial income, schooling and life expectancy, allows fertility to react with respect to infant mortality. It is of note that alternative treatments of these specifications do not alter the key results for tariff rates.

threshold of initial income per capita levels are close to the cut-off level between income rank 1 and rank 2 countries classification. This is also supported by the point estimates of threshold of initial income rank analysis where a country's income level is required to be higher than rank 1 in order to have total positive effect of tariffs on fertility. The threshold level for tariff rates circles around 25%, implying that fertility initially rises with tariffs, and then declines when tariff rates exceed the cut-off level.[24]

Splitting countries into low-half and high-half income groups illustrates, respectively, negative (insignificant) and positive impact of tariffs on fertility. Regarding quantitative significance, the impact on fertility of a 10-percentage-point increase in tariffs is estimated as -0.6% among the low-half income countries, and 3.8% among high-half income countries.

2.3.2.2. Tariffs and Life Expectancy

The estimation results for the life expectancy and tariffs analysis are reported in Table 2-5, where linear and quadratic income terms are, respectively, positive and negative illustrating a highly significant impact on life expectancy. This tendency can be explained by the long-term convergence in life expectancy where the most of the improvements occur in early stages of economic development, and as the percentage of agricultural segment of the population starts to decline when countries become richer, further increases in economic development begin to yield to diminished returns for life expectancy since the broader population enjoys elevated living standards (see Clark, 2011). The estimated effects of tariff rates also demonstrate strong quantitative impact where both the linear and quadratic terms take correct signs. The threshold levels of tariff rates ranges from 17.04% to 24.19%.

Investigation of a non-linear impact of tariffs using interaction terms allows life expectancy to respond to the values of real investment and government expenditure

[24] The threshold levels of tariff rates across different specifications during the analysis vary between 17% and 31%, which is informative for further investigations; and can be helpful for construction of proxies for trade openness where most researchers employed 40% as a breakpoint level for economy's closeness. For example, Rodriguez and Rodrik (2001) criticized Sachs and Warner's (1995) index of openness emphasizing that very little of the dummy's statistical power would be lost if the index was constructed without using the most direct measures of trade - tariff and nontariff barriers where authors applied 40% as a threshold.

ratios, in addition to the original Barro and Lee (1994) specification. Both tariffs and its interaction demonstrate significant differential impacts on life expectancy taking, respectively, negative and positive signs, when an interaction with logged initial income is considered. However, this effect disappears when tariffs are interacted with the World Bank's income ranking index. The point estimates of threshold levels for initial income are lower than the cut-off level of income rank 1 classification.

Note that the signs of estimation results for tariffs and its interaction with initial income contradict expectations of a positive effect for tariffs and a negative effect for the interaction term. Figure 2-3 attempts to find an explanation why it would be the case. The plots illustrate significant positive income effect on life expectancy for the sample when the poorest countries are excluded, while this effect is not significantly different from zero for the lowest income level sample.[25] According to the estimation results, marginal impact of tariff rates becomes to be positive after the breakpoint level of $1543 which matches with the middle of income rank 1 sample. However, it is of note here that the investigation in Section 2.3.1 illustrates a positive significant effect of tariffs on income which starts to marginally decrease after the cut-off level of $5609. Therefore, one might expect tariff rates to marginally increase life expectancy from the level of $1543 up to the threshold level of $5609 and then to observe a negative association between the variables of interest. This is indeed supported by estimation results when the sample is stratified into low-half and high-half income groups. It seems that the positive sign of the interaction term is driven by the fact that the effect of tariffs on life expectancy tends to have larger weight among low-half income countries than among high-half income countries.[26] Taking into consideration all the evidence – (i) differential effect of tariffs on life expectancy occurs after the threshold level of $1543, (ii) income does not affect life expectancy significantly for the lowest income distribution, and (iii) the dominated tariffs effect on life expectancy in low-half subsample – one might expect tariffs and

[25] Partial impact of income on life expectancy for income rank 1 subsample is estimated as 0.150. While not reported separately, this effect increases in magnitude for income rank 2 subsample and reaches its peak illustrating the estimated impact of 0.334; and then starts to decay demonstrating the estimated impact of 0.033 for income rank 3, and 0.026 for income rank 4 subsample. This is consistent with the idea that the link between income and life expectancy is stronger among poorer nations.

[26] Notice that the magnitude of the point estimates of tariffs on life expectancy for low-half subsample dominates the point estimates for high-half subsample.

its interaction term to be, respectively, positively insignificant and positively significant which turns out to be true for linear tariffs term when interaction with the World Bank's income ranking index is employed. However, the interaction term itself, demonstrates insignificant impact, probably reflecting a contradictory effect, perhaps because of the reason that positive and negative tariffs effects on life expectancy, respectively, for low-half and high-half subsamples cancels each other out.

Regarding quantitative significance, the impact on life expectancy of a 10-percentage-point increase in tariffs is estimated as 0.8% among the low-half income countries, and -0.6% among high-half income countries.

2.3.2.3. Tariffs and Infant Mortality

Table 2-6 applies the same analysis for infant mortality. Income shows sensitivity when quadratic term specification is introduced, however demonstrates a highly significant negative impact on mortality when interaction term specification is employed.[27] The intuition here is that higher income could possibly lead to improved nutrition, sanitation, and health care, and would thereby tend to reduce infant mortality.

The estimates of the impact of linear and non-linear tariff rates on mortality take the expected signs under both approaches. The linear and square terms of tariffs demonstrate a strong qualitative impact for both sets of control variables which is also the case when the analysis employs tariff rates interaction with logged initial income. However, the estimates exhibit sensitivity to the introduction of "1 lag restriction" which reduces the precision, while changing the point estimates very little.

When the World Bank's income rank index is used as an interaction term, the linear tariffs measures do not show a significant impact on mortality. The interaction term instead enters significantly illustrating some sensitivity across specifications.

[27] Although the results for income under the first approach are too sensitive, when the analysis employs all available lags instead of "1 lag" instruments, the quadratic term of income illustrate significant negative impact on infant mortality where this association is not significantly different from zero for the linear income term; supporting the idea that the link between income and infant mortality is stronger among wealthier nations, but not among poorer nations (see Brady *et al.*, 2007).

Threshold analysis displays that country's income level is required to be higher than rank 1 in order to have positive effect of tariffs on infant mortality. The breakpoint level for tariff rates ranges between 25% and 31%.

Stratifying countries into low-half (high-half) income groups illustrates a negative (positive) impact of tariffs on infant mortality which is in line with the expectations. Tariffs demonstrate a significant impact only for high-half income subsample. Regarding quantitative significance, the impact on infant mortality of a 10-percentage-point increase in tariffs is estimated as -1.6% among the low-half income countries, and 6.6% among high-half income countries.

2.3.2.4. Tariffs and Education

Table 2-7 reports the estimation results for the relationship between tariffs and school-enrolment ratios at primary level. Estimated specifications examine the dependence of the current school enrolment ratios by gender on income and levels of educational attainment in the presence of tariff rates.[28] The estimation results illustrate no effect of tariff rates on male primary school-enrolment ratio. Application of the tariff interaction with logged initial income demonstrates significant impact of both linear and non-linear terms for female primary school-enrolment ratio, taking, respectively, negative and positive signs; however the significant effect from the linear tariffs term disappears when the World Bank's income rank index is used. The point estimates of threshold levels are lower than the cut-off level of income rank 1 classification.

An analogous situation to the life expectancy and tariffs relationship arises here, where the tariffs and its interaction term were expected to demonstrate, respectively, positive and negative impacts. Figure 2-4 illustrates significant positive income effect on female primary school-enrolment ratio for the lowest income countries, while this effect is nil for the sample when the poorest countries are excluded. The estimation results show that the differential effect of tariff rates appears after the breakpoint level of $1754. Therefore, tariff rates are expected to increase marginally

[28] The estimation results using quadratic terms are not reported since the analysis does not find any significant impact of tariffs. Furthermore, following Barro and Lee (1994) the effect of tariffs on secondary-school enrolment ratio by gender are also investigated, but not reported since the investigation of this relationship did not show any robust evidence between the variables of interest.

the female primary-school enrolment ratio from the level of $1754 up to the threshold level of $5609 and then observe negative association between the variables of interest.[29] It is indeed supported by estimation results when the sample is stratified into low-half and high-half income groups. For both subsamples, the impact of tariffs on female primary schooling is not significantly different from zero.[30]

Overall, the results suggest that the detrimental and generally significant association between tariffs and long-run development indicators is only apparent among rich countries, while this effect is mostly not substantial among poor countries. It seems that for lower income economies, the gains from the implementation of a higher tariff policy have a positive effect on economic growth for a short time period only and mostly are not reflected in development indicators. This is consistent with Bourguignon (2011), who argues that an increase in economic growth does not necessarily mean an increase in development, and GDP of a country can grow without health, education and poverty situations evolving positively.

2.3.3. Tariffs and Infrastructure

The exploration now turns to relationships between tariffs and infrastructure as a potential channel that might drive the effect of tariff rates for low income economies. Part 1 of Table 2-8 reports the results from the non-linear relationship between tariffs and infrastructure proxied by the percentage of paved roads.[31] The linear and non-linear terms of tariffs take, respectively, positive and negative signs across all specifications, implying that the point estimate of the impact of tariffs on paved

---

[29] Income significantly increases female primary schooling up to the cut-off level between income rank 1 and rank 2 country classifications. Therefore, tariffs theoretically can significantly affect female primary schooling up to the level of $2650, and then insignificant impact from tariffs is expected to be observed with the sign depending on which effect (negative or positive) dominates. The estimation results show that point estimates of tariffs on female primary schooling for low-half subsample dominate the point estimates for high-half subsample. Consequently, one might expect tariffs and its interaction term to demonstrate, respectively, positive insignificant and positive significant impact. In order to check whether the significance of tariffs for low-half subsample are affected because of pooling the income rank 1 and rank 2 countries, the investigation runs the same exercise separately for income rank 1 subsample which demonstrates no effect of tariffs on female primary school enrolment ratio.

[30] Following the argument by Galor and Mountford (2008) that in developed countries the gains from trade have been directed towards investment in education, the effect of tariffs on average years of primary, secondary and total schooling over 15 years of age by gender are also investigated. However, the analysis of these relationships did not show any robust evidence between the variables of interest.

[31] These results must be read with caution since their scope is limited only after the 1990s period and to fewer observations than the benchmark exercises.

roads is decreasing with the income level of the economy. OLS estimation results of both tariffs term generally demonstrate significant impact, where turning points ranges between income rank 1 and 2.

System GMM estimation results demonstrate a significant impact of tariffs and its interaction with logged initial income only when potential outliers are eliminated. Using the product of tariffs and the World Bank income rank index exhibits a significant negative impact only for interaction term. The point estimates of the threshold analysis show that country's income level is required to be higher than rank 1 in order to have a differential impact of tariffs.

Part 2 estimates the linear impact of tariffs on infrastructure for different subsamples. Splitting countries into low-half and high-half income groups illustrates, respectively, negative and positive impact of tariffs on paved roads, which is supportive with the predictions. This effect is only significant for high-half income group when the OLS estimator is employed.[32] Regarding quantitative significance, using the estimates produced by the OLS (GMM) estimator, the impact on paved roads of a 10-percentage-point increase in tariffs is estimated as -8.96 (-9.77) percentage points among the high-half income countries, and 0.15 (1.70) percentage points among low-half income countries.

OLS estimation of tariffs effects on infrastructure for each income rank illustrates a significant impact for income ranks 1, 3 and 4 when outlier countries are removed. For each income rank, tariffs mostly take the correct sign illustrating a positive impact for the poorest and lower-middle income countries, and negative impact for higher-middle and the richest income group. The GMM estimation results are essentially consistent with those achieved by OLS. It is of note that significant impact of tariffs on infrastructure appears only for those income ranks where tariffs significantly affect economic growth as described in Part 2 of Table 2-3. Regarding quantitative significance, using the estimates produced by the OLS (GMM) estimator, the impact on growth of a 10-percentage-point increase in tariffs is estimated as 1.6 (1.6) percentage points among the poorest countries, and -11.8 (-15.7) percentage points among the richest countries.

---

[32] Although imprecise, it is of note that the point estimates of tariffs for high-half income group, produced by the GMM estimator, lies within one standard deviation of that achieved via OLS.

These results are consistent with Francois and Manchin's (2013) argument that within developing countries, the reason why the least developed countries underperform in international trade compared with other less developed countries can be explained by the role of physical infrastructure. Alternatively, given that everything else is constant, the gains from trade barriers can increase the quality of infrastructure facilitating a country's competitiveness in trade which might lead to economic growth and development.

2.4. Conclusion

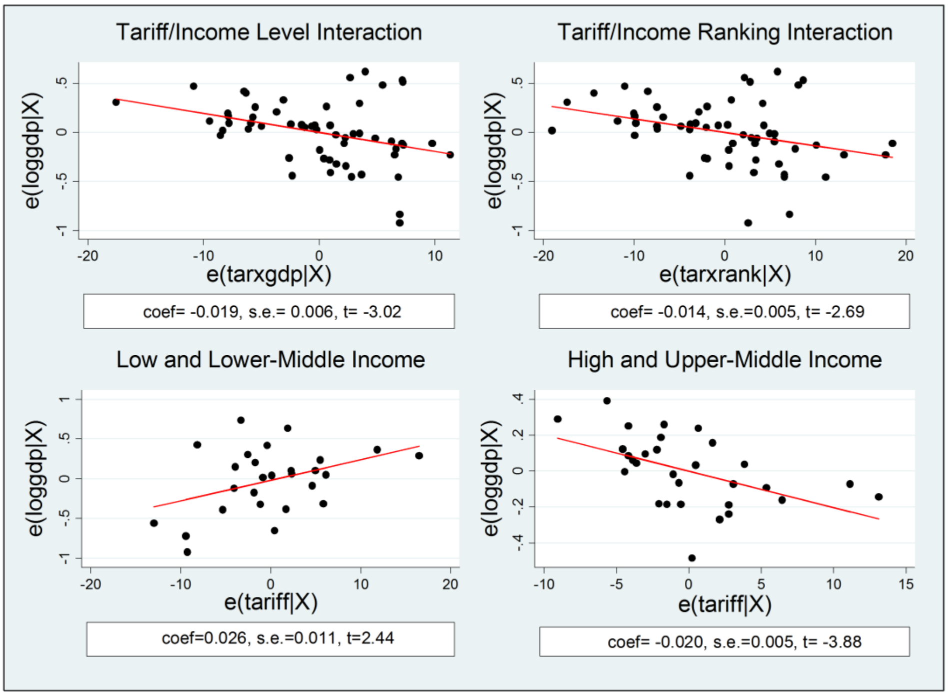
The empirical analysis has confirmed that tariff rates have a differential impact on economic growth with results suggesting that application of limitations to trade is detrimental for economically developed countries, but has a potential to improve growth prospects of developing economies. In addition, the analysis contributes to a trade literature showing that the implementation of high tariff rates in developed economies is harmful not only for economic growth, but also for long-run development indicators. Specifically, the findings demonstrate that all negative associations for growth from tariffs, namely increased fertility and mortality, reduced life expectancy and education are only apparent among the world's rich countries. This effect is robust accross different specifications, and is consitent with predictions of standard neoclassical theory regarding the detrimental effect of trade barriers on a country's economy. However, how the positive significant effect of tariffs on growth is transfered onto the determinants of long-run growth is less clear for lower income economies. Indeed, the significant effect from tariffs appears only for the life expectancy relationship, showing qualitatively weak results for the rest of the development indicators. The exploration of channels through which tariff rates can generate positive growth and development effects for less developed economies reveals that infrastructure might be a potential trigger which mainly drives this effect for the world's poorest countries.

The empirical research was constrained by the limited availability of data on the variables of interest, inducing the analysis to concentrate on relatively small samples (especially when the data set is stratified into separate subsamples) and a short time span (in particular, for the tariffs and infrastructure analysis). Therefore, these results must be read with caution before drawing reliable conclusions and should be taken as a suggestive of the deeper structure linking trade restrictions and development indicators. Short of having the luxury of better and longer data, there is also no obvious way to deal with the robustness constraints imposed by the limitations of the sample.

The analysis also suggests a number of paths for future research concerning the triggers of positive effects on economic growth from trade barriers for developing economies. Various channels by which economic growth can be affected have been discussed in the literature, such as investment, government expenditure, consumption, the trade-off between exports and imports. Although not reported, the analysis attempted to link these relationships with tariffs, but unfortunately, the estimation results did not reveal any robust evidence. However deeper investigation with better data on this is needed.

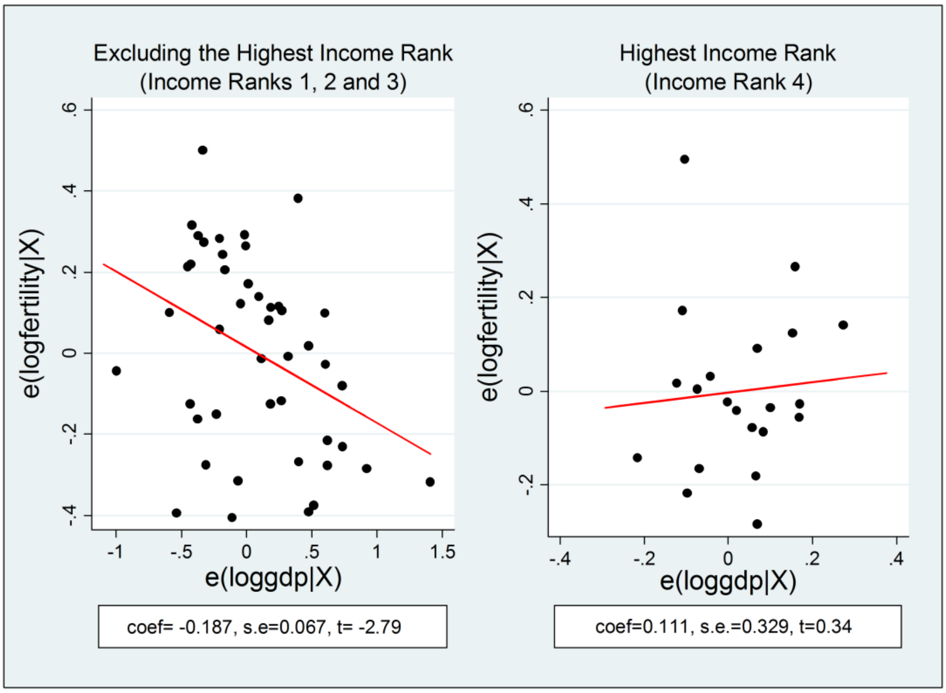
In addition, a particularly promising avenue of future research would be to analyse whether the paucity of evidence from tariffs on indicators of long-run development in lower income economies is driven by the lack of infrastructure in these countries, that is whether the effect of tariffs on development indicators is contingent on infrastructure levels. The analysis of whether trade limitations generate any externalities through different channels such as countries' level of industrialisation and various good sectors is another interesting avenue to investigate.

Figure 2-1: Partial Regression Plots for Tariffs and Economic Growth



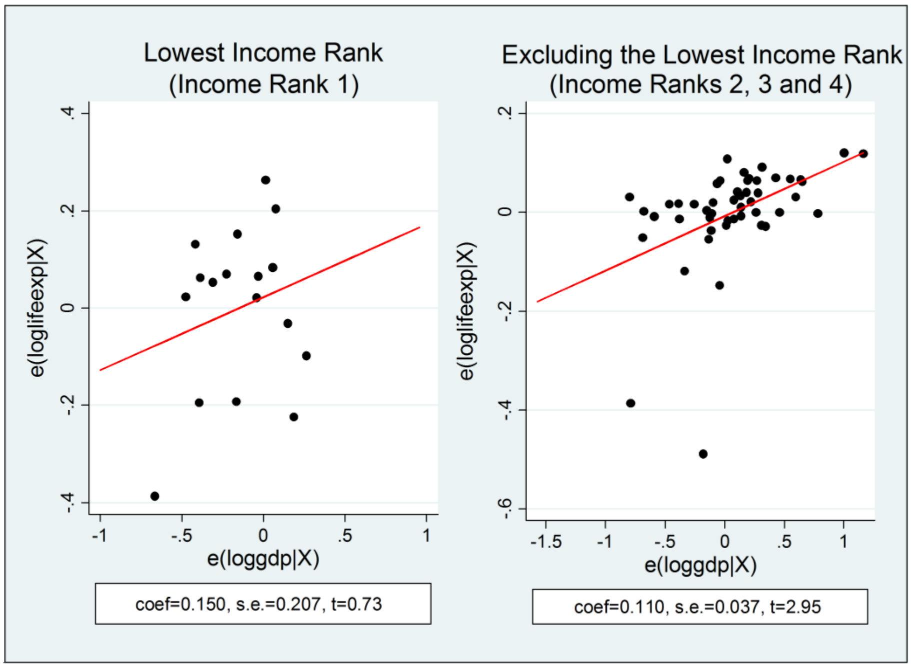
Note: The set of regressors includes log of initial income and life expectancy, schooling (male and female), investment and government expenditure ratios, and time fixed effects. Partial regression plots for interaction terms also include tariffs (linear) into the specification. The figures are produced using OLS regressions.

Figure 2-2: Partial Regression Plots for Fertility and Income



Note: The set of regressors includes tariffs (linear), log of life expectancy and infant mortality, schooling (male and female), and time fixed effects following the specification as defined in Barro and Lee (1994). The figures are produced using OLS regressions.

Figure 2-3: Partial Regression Plots for Life expectancy and Income



Note: The set of regressors includes tariffs (linear), schooling (male and female), and time fixed effects following the specification as defined in Barro and Lee (1994). The figures are produced using OLS regressions.

Figure 2-4: Partial Regression Plots for
Female Primary School-Enrolment Ratio and Income

Note: The set of regressors includes tariffs (linear), schooling (male and female), and time fixed effects following the specification as defined in Barro and Lee (1994). The figures are produced using OLS regressions.

Table 2-1: Descriptive Statistics for Growth and Tariff Rates

Summary Statistics						
Sample split	Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Full sample	Tariffs	70	10.09	7.85	0.01	31.54
	Growth	70	1.45	2.06	-6.49	6.09
High income	Tariffs	21	2.91	3.33	0.01	11.44
	Growth	21	1.87	0.76	-0.89	2.79
Upper-middle	Tariffs	13	8.22	5.89	0.60	22.95
	Growth	13	1.53	1.76	-0.88	5.26
Lower-middle	Tariffs	18	12.90	6.63	2.64	30.33
	Growth	18	1.27	2.34	-3.35	6.09
Low income	Tariffs	18	16.99	6.59	3.68	31.54
	Growth	18	1.07	2.89	-6.49	4.49
High/Upper-Mid.	Tariffs	34	4.94	5.12	0.01	22.95
	Growth	34	1.74	1.23	-0.89	5.26
Lower-Mid./Low	Tariffs	36	14.95	6.84	2.64	31.54
	Growth	36	1.17	2.59	-6.49	6.09

Note: All descriptive statistics are based on cross country averages for 70 countries sample. Growth rates are computed as the first differences of logged income per capita.

Table 2-2: Descriptive Statistics for Development Indicators and Infrastructure

	Full sample	High income	Upper-middle	Lower-middle	Low income	High/ Upper-Mid.	Lower-Mid./Low
Fertility	3.77	1.97	3.23	4.44	5.58	2.45	5.01
	(1.79)	(0.56)	(1.09)	(1.39)	(1.34)	(1.01)	(1.46)
Life Expectancy	65.66	75.19	68.25	62.88	55.43	72.54	59.16
	(9.47)	(1.71)	(5.03)	(7.68)	(6.88)	(4.76)	(8.12)
Infant Mortality	48.71	10.99	37.61	61.51	87.94	21.17	74.72
	(40.03)	(5.49)	(23.53)	(40.03)	(28.68)	(19.79)	(36.84)
Female Prim. Sch. Enr.	90.29	98.95	98.86	89.75	75.49	98.92	82.62
	(15.99)	(1.94)	(2.68)	(17.78)	(17.65)	(2.18)	(18.89)
Male Prim. Sch. Enr.	95.23	98.87	99.67	94.87	88.65	99.15	91.76
	(9.04)	(2.07)	(0.73)	(9.39)	(12.39)	(1.75)	(11.28)
Paved Roads	56.74	76.80	43.02	50.55	43.84	64.13	47.87
	(33.66)	(26.87)	(33.58)	(33.78)	(32.74)	(33.33)	(32.67)

Note: The descriptive statistics of fertility, life expectancy and infant mortality are based on cross country averages of 70 countries. Summary of primary enrolment ratio measures by gender is restricted to 68 countries sample. The respective statistics of paved roads are summarized for 44 countries data set. Standard deviations are presented in the parentheses.

Table 2-3: Part 1
Tariffs and Growth Relationship
Dependent Variable: Logged per capita real (Laspeyres) GDP
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	TARIFF/INCOME LEVEL INTERACTION		**TARIFF/INCOME RANK INTERACTION**		**SPLITTING into INCOME GROUPS**		**OUTLIERS REMOVED**	
	Main Model	Outliers Removed	Main Model	Outliers Removed	Low-half	High-half	Low-half	High-half
Initial GDP p.c. (log)	0.933***	0.951***	0.949***	0.953***	0.860***	0.842***	0.869***	0.856***
	(0.039)	(0.039)	(0.035)	(0.038)	(0.065)	(0.053)	(0.056)	(0.036)
Tariffs (ad-valorem)	**0.033****	**0.041*****	**0.008*****	**0.009*****	**0.005***	**-0.005****	**0.006****	**-0.009****
	(0.013)	**(0.011)**	**(0.002)**	**(0.002)**	**(0.003)**	**(0.003)**	**(0.003)**	**(0.004)**
Tariffs*GDP	**-0.004****	**-0.005*****						
	(0.002)	**(0.001)**						
Tariffs*RANK			**-0.003*****	**-0.005*****				
			(0.001)	**(0.001)**				
Life expectancy (log)	0.559**	0.644**	0.466*	0.557**	1.032**	0.621*	0.895**	0.696
	(0.237)	(0.272)	(0.251)	(0.267)	(0.413)	(0.356)	(0.388)	(0.437)
Secondary schooling (female)	0.033	0.048	0.007	0.073	0.003	-0.089	0.010	0.027
	(0.082)	(0.094)	(0.082)	(0.090)	(0.142)	(0.084)	(0.114)	(0.088)
Secondary schooling (male)	-0.035	-0.080	-0.006	-0.092	0.006	0.108	0.015	-0.006
	(0.083)	(0.097)	(0.086)	(0.092)	(0.125)	(0.089)	(0.106)	(0.087)
I/Y (Investment/GDP)	0.005**	0.004**	0.005*	0.0037	0.006*	0.005***	0.008***	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
G/Y (Government burden/GDP)	-0.008***	-0.008***	-0.008***	-0.008***	-0.014***	-0.003	-0.013***	-0.004**
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
Countries/Observations	60/267	56/249	60/267	55/245	28/118	32/149	25/105	28/130
Threshold analysis								
Initial GDP p.c.	5609	3159						
	(3182)	(1417)						
Income Rank			2.45	1.82				
			(0.617)	(0.377)				
SPECIFICATION TESTS (*p* -values)								
(a) Hansen Test:	0.342	0.632	0.445	0.570	0.428	0.483	0.647	0.463
(b) Serial Correlation:								
First-Order	0.000	0.000	0.000	0.000	0.012	0.007	0.019	0.002
Second-Order	0.922	0.880	0.920	0.806	0.242	0.392	0.665	0.769

Note: All estimated results are achieved using the "1 lag restriction" technique following Roodman (2009). The excluded countries for tariff/income level interaction specification are Iran, Korea Rep., Papua New Guinea and Sierra Leone. In addition, Iceland is also excluded for tariff/income rank interaction specification. Eliminated countries from low-half income group are Korea Rep., Papua New Guinea and Sierra Leone, while Ireland, Iran, Iceland and South Africa are excluded for high-half income subsample. The outliers are singled out using OLS regressions. All specifications also control for time fixed effects. Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions), investment ratio and the ratio of government expenditure to GDP as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-3: Part 2
Tariffs and Growth Relationship
Dependent Variable: Logged per capita real GDP
Estimation: Ordinary Least Squares (OLS) and GMM System

	OLS						**GMM System**					
	Full Subsamples			**Outliers Removed**			**Full Subsamples**			**Outliers Removed**		
	impact	std.error	p value	impact	std.error	p value	impact	std.error	p value	impact	std.error	p value
Income Rank 1	0.004	0.001	0.008	0.006	0.002	0.001	0.005	0.003	0.081	0.007	0.003	0.046
Income Rank 2	0.001	0.003	0.860	0.002	0.003	0.307	0.002	0.004	0.598	0.003	0.004	0.539
Income Rank 3	-0.007	0.005	0.176	-0.010	0.007	0.146	-0.007	0.003	0.041	-0.010	0.007	0.212
Income Rank 4	-0.007	0.002	0.007	-0.009	0.002	0.000	-0.006	0.003	0.021	-0.012	0.002	0.000

Note: All specifications control for log of initial income and life expectancy, schooling (male and female), investment and government expenditure ratios and time fixed effects. For the GMM system estimator under the specification when outliers removed, the estimated results are achieved using the "1 lag restriction" technique following Roodman (2009). The excluded countries from income rank 1 sample are Botswana and Papua New Guinea; from income rank 2 are Korea Rep. and Sierra Leone; from income rank 3 are Ireland, Iran and South Africa; and from income rank 4 are Austria, Iceland and Venezuela. The outliers are singled out using OLS regressions. The number of countries/observations for each subsample (the number of countries/observations from removing outliers is presented in parentheses) is as following: income rank 1- 15/63 (13/54); income rank 2 – 13/55 (11/47); income rank 3- 11/51 (8/36); income rank 4 – 21/98 (18/85). Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions), investment ratio and the ratio of government expenditure to GDP as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-4
Tariffs and Fertility Relationship
Dependent Variable: Logged fertility (woman's prospective number of live births)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Basic Relationship	**Barro-Lee Specification with Tariffs**	**TARIFF/INCOME LEVEL INTERACTION**		**TARIFF/INCOME RANK INTERACTION**		**SPLITTING into INCOME GROUPS**		**OUTLIERS REMOVED**	
			Main Model	Outliers Removed	Main Model	Outliers Removed	Low-half	High-half	Low-half	High-half
Initial GDP p.c. (log)	-2.737***	-0.623	-0.283***	-0.282***	-0.306***	-0.283***	-0.182	-0.194*	-0.111	-0.175*
	(0.987)	(0.628)	(0.094)	(0.102)	(0.091)	(0.095)	(0.125)	(0.105)	(0.137)	(0.096)
Initial GDP p.c. (log) squared	0.134**	0.025								
	(0.057)	(0.034)								
Tariffs (ad-valorem)	**0.033****	**0.028*****	**-0.073****	**-0.087***	**-0.010**	**-0.010**	**-0.002**	**0.018*****	**-0.003**	**0.019*****
	(0.014)	**(0.009)**	**(0.034)**	**(0.046)**	**(0.009)**	**(0.009)**	**(0.007)**	**(0.007)**	**(0.007)**	**(0.006)**
Tariff squared	**-0.0007*****	**-0.0006*****								
	(0.0002)	**(0.0002)**								
Tariffs*GDP			**0.009****	**0.011****						
			(0.004)	**(0.006)**						
Tariffs*RANK					**0.008****	**0.009****				
					(0.003)	**(0.003)**				
Life expectancy (log)		4.525	-2.261***	-2.170***	-1.974***	-1.800***	-0.788	-2.909***	-0.930	-2.974***
		(11.859)	(0.606)	(0.689)	(0.529)	(0.584)	(0.778)	(0.616)	(0.766)	(0.638)
Life expectancy (log) squared		-0.729								
		(1.493)								
Secondary schooling (male)		0.245	-0.017	-0.119	-0.011	-0.081	0.068	-0.131	-0.013	-0.141
		(0.233)	(0.096)	(0.105)	(0.104)	(0.109)	(0.136)	(0.155)	(0.145)	(0.139)
Secondary schooling (male) squared		-0.032*								
		(0.019)								
Secondary schooling (female)		-0.174	0.035	0.115	0.024	0.068	-0.099	0.146	-0.037	0.153
		(0.185)	(0.099)	(0.111)	(0.103)	(0.111)	(0.132)	(0.149)	(0.140)	(0.132)
Secondary schooling (female) squared		0.027*								
		(0.016)								
I/Y (Investment/GDP)		0.017	0.004	0.006	0.005	0.007	-0.005	0.009	-0.006	0.009
		(0.014)	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)
I/Y (Investment/GDP) squared		-0.0003								
		(0.0002)								
G/Y (Gov. exp./GDP)		-0.018	0.011***	0.013***	0.010***	0.013***	-0.014***	0.009	0.014***	0.011
		(0.016)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.012)	(0.004)	(0.011)
G/Y (Gov. exp./GDP) squared		0.0005*								
		(0.0003)								
Countries/Observations	70/303	70/303	70/303	67/292	70/303	66/289	36/147	34/156	34/142	33/152
Threshold analysis										
Tariff Rate (%)	23.58	24.18								
	(4.54)	(3.63)								
Initial GDP p.c.			2014	2083						
			(1180)	(1038)						
Income Rank					1.27	1.15				
					(0.715)	(0.706)				
SPECIFICATION TESTS (*p* -values)										
(a) Hansen Test:	0.183	0.827	0.846	0.219	0.920	0.133	0.971	0.989	0.936	0.971
(b) Serial Correlation:										
First-Order	0.000	0.002	0.001	0.029	0.000	0.000	0.025	0.042	0.015	0.052
Second-Order	0.237	0.233	0.281	0.183	0.697	0.372	0.184	0.583	0.203	0.837

Note: All results are achieved using the "1 lag restriction" technique following Roodman (2009), except the estimates for the "Main model" specifications. The excluded countries for tariff/income level interaction specification are Iceland, Israel and Togo. In addition, Paraguay is also excluded for tariff/income rank interaction specification. Eliminated countries from low-half income group are Ghana and Togo; and from high-half income group is Iceland. The outliers are singled out using OLS regressions. All specifications also control for time fixed effects. Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions), income and schooling as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-5

Tariffs and Life Expectancy Relationship

Dependent Variable: Logged life expectancy (at birth, total years)

Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Basic Relationship	**Barro-Lee Specification with Tariffs**	**TARIFF/INCOME LEVEL INTERACTION**		**TARIFF/INCOME RANK INTERACTION**		**SPLITTING into INCOME GROUPS**		**OUTLIERS REMOVED**	
							Low-half	High-half	Low-half	High-half
Initial GDP p.c. (log)	0.901***	0.527**	0.048*	0.068***	0.061**	0.075***	0.146**	0.043***	0.161***	0.049***
	(0.212)	(0.201)	(0.027)	(0.021)	(0.026)	(0.022)	(0.057)	(0.014)	(0.043)	(0.017)
Initial GDP p.c. (log) squared	-0.046***	-0.026**								
	(0.012)	(0.011)								
Tariffs (ad-valorem)	**-0.006****	**-0.005***	**-0.027****	**-0.021***	**0.002**	**0.003**	**0.005***	**-0.003****	**0.004***	**-0.003***
	(0.003)	**(0.002)**	**(0.013)**	**(0.011)**	**(0.004)**	**(0.003)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.001)**
Tariffs squared	**0.00013****	**0.00013****								
	(0.00005)	**(0.00005)**								
Tariffs*GDP			**0.004****	**0.003****						
			(0.002)	**(0.001)**						
Tariffs*RANK					**0.0002**	**0.0001**				
					(0.0013)	**(0.001)**				
Sec. sch. (male)		-0.029	-0.002	-0.004	-0.004	-0.025	0.065*	0.019	0.039	0.031
		(0.058)	(0.033)	(0.027)	(0.037)	(0.031)	(0.032)	(0.019)	(0.035)	(0.021)
Sec. sch. (male) squared		0.004								
		(0.006)								
Sec. sch. (female)		0.077	0.025	0.022	0.033	0.043	-0.039	-0.013	-0.018	-0.021
		(0.051)	(0.033)	(0.026)	(0.039)	(0.032)	(0.031)	(0.018)	(0.034)	(0.021)
Sec. sch. (female) squared		-0.007								
		(0.005)								
I/Y (Investment/GDP)				0.002*		0.003*	0.002	0.002	0.001	0.001
				(0.001)		(0.0016)	(0.003)	(0.002)	(0.002)	(0.001)
G/Y (Government exp./GDP)				0.003		0.002	0.002	0.001	0.001	-0.001
				(0.002)		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Countries/Observations	70/303	70/303	70/303	70/303	70/303	70/303	36/147	34/156	34/138	33/151
Threshold analysis										
Tariff Rate (%)	24.19	17.04								
	(5.60)	(4.22)								
Initial GDP p.c.			1543	1418						
			(937)	(905)						
SPECIFICATION TESTS (*p* -values)										
(a) Hansen Test:	0.697	0.217	0.884	0.212	0.326	0.182	0.827	0.934	0.833	0.876
(b) Serial Correlation:										
First-Order	0.009	0.054	0.038	0.033	0.002	0.019	0.636	0.033	0.979	0.033
Second-Order	0.247	0.531	0.211	0.347	0.043	0.102	0.268	0.698	0.259	0.662

Note: The estimation results are achieved using the "1 lag restriction" following Roodman (2009). Excluded countries from low-half income group are Nicaragua and Syria; and from high-half income group is Costa Rica. For the interaction terms specifications, the results excluding outliers are not reported since elimination of potential outliers does not alter the results. The outliers are singled out using OLS regressions. All specifications also control for time fixed effects. Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions), income and investment ratio as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-6
Tariffs and Infant Mortality Relationship
Dependent Variable: Logged infant mortality (rate under-five, per 1000)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Basic Relationship	Barro-Lee Specification with Tariffs	TARIFF/INCOME LEVEL INTERACTION				TARIFF/INCOME RANK INTERACTION				SPLITTING into INCOME GROUPS	
			a	b	a	b	a	b	a	b	**Low-half**	**High-half**
Initial GDP p.c. (log)	0.906	1.746	-0.981***	-1.002***	-0.877***	-0.854***	-0.961***	-0.953***	-0.964***	-0.878***	-0.513**	-0.946***
	(1.495)	(1.439)	(0.097)	(0.098)	(0.162)	(0.148)	(0.098)	(0.094)	(0.179)	(0.162)	(0.215)	(0.229)
Initial GDP p.c. (log) squared	-0.097	-0.133										
	(0.087)	(0.083)										
Tariffs (ad-valorem)	**0.049****	**0.052*****	**-0.145***	**-0.149**	**-0.127****	**-0.112**	**-0.015**	**-0.015**	**-0.012**	**-0.016**	**-0.008**	**0.033****
	(0.019)	**(0.017)**	**(0.073)**	**(0.106)**	**(0.054)**	**(0.066)**	**(0.017)**	**(0.019)**	**(0.015)**	**(0.016)**	**(0.008)**	**(0.015)**
Tariffs squared	**-0.0008****	**-0.0010*****										
	(0.0004)	**(0.0003)**										
Tariffs*GDP			**0.019****	**0.019**	**0.015****	**0.014**						
			(0.009)	**(0.013)**	**(0.007)**	**(0.008)**						
Tariffs*RANK							**0.011***	**0.012**	**0.007**	**0.011***		
							(0.006)	**(0.007)**	**(0.006)**	**(0.006)**		
Sec. sch. (male)		0.489			0.182	0.075			0.214	0.093	-0.170	-0.112
		(0.336)			(0.169)	(0.163)			(0.184)	(0.166)	(0.152)	(0.272)
Sec. sch. (male) squared		-0.046										
		(0.031)										
Sec. sch. (female)		-0.601**			-0.272*	-0.171			-0.244	-0.155	-0.004	0.046
		(0.273)			(0.159)	(0.162)			(0.179)	(0.166)	(0.128)	(0.274)
Sec. sch. (female) squared		0.052*										
		(0.027)										
Countries/Observations	70/303	70/303	70/303	70/303	70/303	70/303	70/303	70/303	70/303	70/303	35/144	31/141
Threshold analysis												
Tariff Rate (%)	31.13	24.85										
	(4.12)	(2.07)										
Initial GDP p.c.			2302	2467	3863	3783						
			(1112)	(1293)	(1655)	(2263)						
Income Rank							1.31	1.27	1.67	1.56		
							(0.842)	(0.919)	(1.12)	(0.864)		
SPECIFICATION TESTS (*p* -values)												
(a) Hansen Test:	0.356	0.393	0.680	0.497	0.277	0.621	0.664	0.488	0.325	0.610	0.774	0.416
(b) Serial Correlation:												
First-Order	0.039	0.170	0.981	0.974	0.938	0.904	0.044	0.045	0.057	0.077	0.101	0.365
Second-Order	0.944	0.556	0.546	0.545	0.275	0.266	0.214	0.207	0.107	0.120	0.037	0.252

Note: Columns "a" apply all possible lags as instruments, while the rest of the estimation results are achieved using the "1 lag restriction" technique following Roodman (2009). Excluded countries from high-half income group are Iran, South Africa and USA; and from low-half income group is Ghana. For the interaction term specifications, the results excluding outliers are not reported since elimination of potential outliers does not alter the results. The outliers are singled out OLS regressions. All specifications also control for time fixed effects. Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions) and income as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-7
Tariffs and Education Relationship
Dependent Variable: Primary-school enrollment ratio (male and female)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	TARIFF/INCOME LEVEL INTERACTION		**TARIFF/INCOME RANK INTERACTION**		**SPLITTING into INCOME GROUPS**			
					Low-half		**High-half**	
	male primary	female primary	male primary	female primary	male primary	female primary	male primary	female primary
Initial GDP p.c. (log)	4.027	1.287	3.984	2.396	4.779	4.666	0.067	-0.511
	(3.254)	(5.901)	(3.023)	(5.583)	(4.704)	(9.629)	(0.831)	(0.731)
Tariffs (ad-valorem)	**-2.156**	**-5.869*** **	**0.065**	**-0.226**	**0.256**	**0.162**	**-0.100**	**-0.132**
	(1.533)	**(2.004)**	**(0.283)**	**(0.433)**	**(0.237)**	**(0.336)**	**(0.111)**	**(0.086)**
Tariffs*GDP	**0.304**	**0.786*** **						
	(0.188)	**(0.246)**						
Tariffs*RANK			**0.102**	**0.333***				
			(0.119)	**(0.187)**				
Sec. sch. (male)	0.514	-2.414	1.875	0.609	6.727	2.890	-0.887	-0.445
	(3.037)	(4.765)	(3.071)	(4.480)	(5.902)	(7.124)	(1.093)	(1.111)
Sec. sch.(female)	-0.354	5.012	-1.536	2.074	-3.847	4.186	0.214	0.133
	(2.763)	(4.483)	(2.771)	(3.839)	(5.016)	(6.745)	(1.125)	(1.081)
Countries/Observations	68/261	68/261	68/261	68/261	36/127	36/127	32/134	32/134
Threshold analysis								
Initial GDP p.c.	1207	1754						
	(1142)	(786)						
Income Rank				0.68				
				(1.04)				
SPECIFICATION TESTS (*p* -values)								
(a) Hansen Test:	0.427	0.755	0.299	0.413	0.602	0.421	0.898	0.493
(b) Serial Correlation:								
First-Order	0.114	0.794	0.123	0.413	0.167	0.071	0.344	0.523
Second-Order	0.425	0.855	0.387	0.985	0.491	0.960	0.207	0.746

Note: All estimation results are achieved using the "1 lag restriction" technique following Roodman (2009). The results excluding outliers are not reported since elimination of potential outliers does not alter the results. All specifications also control for time fixed effects. Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions) and income as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-8: Part 1
Tariffs and Infrastructure Relationship
Dependent Variable: Roads, paved (% of total roads)
Estimation: Ordinary Least Squares (OLS) and GMM System

	OLS				**GMM System**			
	TARIFF/INCOME LEVEL INTERACTION		**TARIFF/INCOME RANK INTERACTION**		**TARIFF/INCOME LEVEL INTERACTION**		**TARIFF/INCOME RANK INTERACTION**	
	Main Model	Outliers Removed	Main Model	Outliers Removed	Main Model	Outliers Removed	Main Model	Outliers Removed
Initial GDP p.c. (log)	31.465***	30.051***	33.835***	28.366***	72.828***	59.384***	44.607**	36.989
	(7.446)	(5.415)	(6.325)	(6.001)	(23.957)	(17.149)	(21.993)	(25.595)
Tariffs (ad-valorem)	**6.166**	**14.467*** **	**2.444*** **	**2.779*** **	**6.437**	**23.986** **	**3.405**	**4.817**
	(3.812)	**(2.776)**	**(0.631)**	**(0.581)**	**(20.497)**	**(10.315)**	**(2.040)**	**(2.938)**
Tariffs*GDP	**-0.729**	**-1.803*** **			**-0.759**	**-3.004** **		
	(0.495)	**(0.369)**			**(2.746)**	**(1.407)**		
Tariffs*RANK			**-1.233*** **	**-1.336*** **			**-2.619***	**-3.148** **
			(0.269)	**(0.212)**			**(1.426)**	**(1.493)**
Life expectancy (log)	39.183	70.326**	43.314	132.441**	3.795	-7.149	-11.714	0.457
	(35.459)	(35.201)	(40.242)	(58.335)	(245.563)	(178.599)	(199.835)	(345.601)
Secondary schooling (female)	-77.875***	-57.683***	-64.187***	-59.319***	-137.028	-69.721	-65.019	23.443
	(21.711)	(16.023)	(19.246)	(16.955)	(128.017)	(65.508)	(129.847)	(87.638)
Secondary schooling (male)	73.583***	53.362***	59.587***	54.695***	91.899	53.127	42.461	-32.654
	(22.057)	(16.023)	(19.406)	(16.174)	(143.423)	(75.484)	(131.302)	(92.833)
I/Y (Investment/GDP)	0.835	0.388	0.698	0.362	0.763	-0.364	0.912	0.306
	(0.543)	(0.315)	(0.437)	(0.325)	(2.108)	(1.230)	(1.302)	(1.205)
G/Y (Government exp./GDP)	0.406	-0.261	0.506	-0.317	-0.555	0.186	0.179	1.025
	(0.599)	(0.357)	(0.563)	(0.346)	(1.743)	(0.908)	(1.489)	(1.239)
Countries/Observations	44/75	40/68	44/75	40/69	44/75	40/68	44/75	40/69
R-squared	0.62	0.78	0.68	0.77				
Hansen Test					0.573	0.326	0.569	0.788
Threshold analysis								
Initial GDP p.c.	4703	3059			4782	2932		
	(4162)	(786)			(22494)	(1650)		
Income Rank			1.98	2.08			1.29	1.53
			(0.408)	(0.388)			(0.769)	(0.641)

Note: The excluded countries for tariff/income level interaction specification are Egypt, Jordan, Mauritius and Thailand. The excluded countries for tariff/income rank interaction specification are the same set of countries where Mauritius is replaced with Sierra Leone. The outliers are singled out using OLS regressions. All specifications also control for time fixed effects. Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions), income, investment ratio and the ratio of government expenditure to GDP as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1975-2000 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

Table 2-8: Part 2
Tariffs and Infrastructure Relationship
Dependent Variable: Roads, paved (% of total roads)
Estimation: Ordinary Least Squares (OLS) and GMM System

	OLS						**GMM System**					
	Full Subsamples			**Outliers Removed**			**Full Subsamples**			**Outliers Removed**		
	impact	std.error	p value	impact	std.error	p value	impact	std.error	p value	impact	std.error	p value
High-half	-4.834	1.357	0.001	-4.480	1.063	0.000	-5.427	6.873	0.438	-4.883	5.712	0.402
Low-half	0.085	0.667	0.899	0.076	0.688	0.913	1.111	1.151	0.346	0.852	1.719	0.627
Income Rank 1	0.772	0.382	0.100	0.793	0.176	0.011	0.605	0.373	0.149	0.793	0.165	0.003
Income Rank 2	0.843	1.233	0.508	1.144	1.819	0.553	0.957	1.995	0.641	-0.004	3.588	0.999
Income Rank 3	-1.065	0.609	0.124	-2.203	0.599	0.014	-1.727	0.796	0.062	-2.236	0.631	0.009
Income Rank 4	-6.766	0.964	0.000	-5.891	1.298	0.001	-8.206	8.872	0.371	-7.845	4.507	0.107

Note: All specifications employ log of initial income and life expectancy, average years of secondary schooling by gender, investment and government expenditure ratios, and time fixed effects as an additional control set. Eliminated countries from high-half income group are Hungary and Israel; from low-half income group are Egypt, Jordan and Thailand; from income rank 1 is Egypt; from income rank 2 are Jordan, Nicaragua and Sierra Leone; from income rank 3 is Hungary; and from income rank 4 are Austria and Israel. The outliers are singled out using OLS regressions. The number of countries/observations for each subsample (the number of countries/observations from removing outliers is presented in parentheses) is as following: high-half income group- 24/41 (22/37); low-half income group- 20/34 (17/29); income rank 1- 8/14 (7/13); income rank 2 – 12/20 (9/15); income rank 3- 9/16 (8/14); income rank 4 – 15/25 (13/22). Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats tariff rates (and its interactions), income, investment ratio and the ratio of government expenditure to GDP as endogenous, while other variables employed in the specification as predetermined. The time span for the analysis is based on balanced dataset for the 1990-2000 period (T=2). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels.

3. Military Spending and Growth: An Empirical Exploration of Contingent Relationships

3.1. Introduction

The economic effects of military spending continue to be the subject of considerable debate, with a lack of consensus in the literature. How does military expenditure affect a country's economic growth? And how do these effects vary across economies? These are important questions, as the effects of military spending, on one hand, may just represent a budgetary burden which is necessitated by a country's need for some level of security; on the other hand, it may also serve for growth by delivering significant "peace dividends" and attract additional revenues into a country's budget through the defence industry (e.g., arms trading, technology transfers).

This investigation makes a contribution to the debate on the economic effects of military spending, in light of the ambiguous outcomes found in the military spending and economic growth literature, by reassessing the relationship contingent on the level of initial income per capita. Although growth falls with higher levels of military spending, the results reveal that conditional on the values of other independent variables, the marginal impact of military spending is increasing in initial income levels. In particular, this relationship is negative and significant amongst poor countries, while typically not significantly different from zero amongst richer countries. In contrast to previous research, this contingency pattern continues to hold under an alternative modelling strategy in which the data set is stratified into different income categories and types of economies, as well as its robustness along several dimensions; and is monotonic in direction, converging towards zero for sufficiently high income level countries, which explains the ambiguity in previous findings.

The debate regarding the economic effects of military spending is founded in the contribution of Benoit (1973, 1978) which ignited a subsequent tranche of research employing a variety of econometric models, reflecting different theoretical perspectives. Keynesian, neoclassical and structuralist models were applied using a variety of specifications, econometric estimators and types of sample in cross-sectional, time-series or panel datasets. The diversity of results led to arguments for case studies of individual countries and relatively homogeneous groups of countries. However, the literature has not reached a consensus. For instance, Dunne and Uye (2009) in a survey of 102 studies on the economic effects of military spending, report that almost 39% of the cross-country studies and 35% of the case studies find a negative effect of military spending on growth, with around 20% finding positive impacts for both types of studies.[33]

The explanation behind the heterogeneous outcomes for the relationship between growth and military spending can be broadly grouped by demand, supply and security effects of military sector on economic performance, where the following discussions of these effects heavily draws on those developed in Dunne *et al.* (2005). Demand effects for the relationship between economic growth and military spending are driven by decisions on allocating state expenditure or diversification of state resources into military complex as an alternative to different sectors of domestic use, and can have both short-run and long-run components, which might act in opposite directions generating both positive and negative impact on economic growth. For instance, a rise in military spending, on one hand, may increase aggregate domestic demand in the short run, thereby exerting a Keynesian multiplier effect on economic growth rate by generating a rise in capacity utilisation that will increase current output, and hence leading to increased profits, investment and economic growth. On the other hand, sustained increases in military expenditure might undermine a country's growth performance since these short-run effects do not necessarily always lead to higher levels of capital formation. Alternatively, increases in military spending are likely to induce a negative impact on output growth in the long run by generating industrial inefficiencies that can reduce the efficiency of resource

[33] Previous surveys of the military spending and growth literature also include Chan (1987), who found a lack of consistency in the results; Ram (2003) who reviewed 29 studies, concluding that there is little evidence of a positive effect of defence outlays on growth, but that it was also difficult to say that the evidence supported a negative effect. Dunne (1996, chap. 23) covering 54 studies concluded that military spending had at best no effect on growth and was likely to have a negative effect; and Smith (2000) concluded that the large literature did not indicate any robust empirical regularity, positive or negative, though he suggested there is a small negative effect in the long run. Smaldone (2006) in his review of Africa, considers military spending relationship to be heterogeneous, but feels that variations can be explained by intervening variables. The effects can be both positive and negative but are usually not pronounced, although the negative effects tend to be wider and deeper in Africa and most severe in countries experiencing legitimacy/security crisis and economic/budgetary constraints.

allocation, thereby lowering total factor productivity. For instance, as discussed in Knigh *et al.* (1996), increases in military spending are expected to decrease the total stock of resources that is available for alternative domestic uses such as investment in (public and private) productive capital, education, health and technological innovation, generating crowding-out effects. The size and direction of crowding-out effects will also determine a country's growth prospects depending on how the increase in military spending is financed, which according to government budget constraints can be realized either by cutting other public expenditure, raising current taxes and increasing borrowing (future taxes) or expansion in the money supply. All these approaches will have further effects which will also reflect in different sectors of an economy, and hence a country's growth performance. For example, raising current taxes or borrowing will lower the expected after-tax return on productive capital, while simultaneously reducing the flow of (domestic plus foreign) savings that is available to finance productive capital formation in the domestic economy which will be accommodated by a fall in public sector investment and private consumption.

Supply effects of military sector are reflected in an economy's growth prospects through the availability of factors of output production such as labour, physical and human capital, natural resources, as well as technology, which can also have both negative and positive effects. For instance, military sector, on one hand, may attract scarce labour and valuable resources away from the civilian industrial sector at the expense of education and training expenditures restricting an economy's potential growth prospects. However, on the other hand, the training in the armed forces may also provide workers valuable technical, organisational and administrative skills making them more productive when they return to civilian life. Furthermore, military R&D is also more likely to have commercial spin-offs depending on the degree of a country's development level and the existence of an advanced sector with trained and educated workforce.

Security effects can be generated by the demand of a state to protect its sovereignty from domestic and foreign threats in order to provide an environment for the economy to successfully operate where military sector acts as a premium guard for the security of persons and property, and gives incentives to invest and innovate. Although long-lasting conflicts are major obstacles to achieve sustainable development in many poor countries and having strong military sector can generate positive externalities for growth by providing stability, increases in military expenditures may also be driven by rent seeking actions by military industrial complex instead of by security needs. In such cases, increases in military spending may aggravate arms races or damaging wars offsetting positive security effects generated by military sector.

As mentioned above, many of these effects are contingent, depending on employment level of available resources, on how increases in military spending is financed, the sources of potential externalities from military sector and the effectiveness of military complex in responding to the domestic and foreign threats. Clearly all these factors – military spending, conflict and economic capacity (education, governance, institutions and resource endowments), all interact to influence growth. And all the interactions of these channels and their influence on economic growth will vary on the countries under examination and depend on their economic/budgetary constraints. For example, a relatively advanced developing country, such as one of the "Asian Tigers" by investing into military sector will have interests over the industrial impact of its involvement in arms production, the technology and the foreign direct investment benefits vs. the opportunity costs, while a poorer African economy may be more concerned with the conflict trap it finds itself in, i.e. directing budgetary sources into military sector instead of welfare-improving projects is likely to be more detrimental in poorer countries.

A simple illustration of how the impact of military spending on economic growth can vary conditional on countries' income level, presented in Figure 3-1, indeed provides support for this view, while also casting some doubt on the desirability of pooling all the nations together in the econometric analysis without taking into account the possibility that the effect of military spending is contingent on income.[34] The plots illustrate a significant negative impact of military expenditure on growth for the low income subsample, while this effect becomes less and less negative going

[34] Scatter plots and fitted relationships between the variables of interest for four income groups are achieved using partial regressions which are obtained in two stages. First, both the dependent variable and the isolated independent variable are projected onto the additional set of regressors under consideration. Next, the residuals of the dependent variable are regressed against the residuals of the independent variable. The figures are produced using OLS panel regressions where growth and military expenditure is related linearly.

towards zero for relatively richer countries, perhaps reflecting a contradictory effect induced by positive income effects gained as peace dividends which cancel the detrimental effects out.[35]

The remainder of the paper is organized as follows. The methodology and data employed are described in Section 3.2. Section 3.3 presents the estimation results using a more formal analysis which confirm the presence of the contingency that plots above illustrate, as well as its robustness along several dimensions; and Section 3.4 concludes.

3.2.1. Empirical Methodology

Many different estimators have been used to examine the relationship between growth and military spending, with associated advantages and disadvantages to each method. This section begins with a brief discussion of these estimators in order to motivate the approach to estimation analysis. Then the discussion turns to the method used to explore the potential contingencies in the relationship between military expenditure and growth.

Letting the subscripts *i* and *t* represent country and time period respectively, the estimated growth model with introduction of military expenditure can be written as

$$y_{it} - y_{i(t-1)} = \alpha\, y_{i(t-1)} + \theta_1 mil_{it} + \beta' Z_{it} + \mu_t + \xi_i + \varepsilon_{it} \tag{3i}$$

where y is log of real per capita income, mil_{it} is military spending, Z_{it} is a vector of additional control variables, μ_t is a period-specific constant, ξ_i is an unobserved country-specific effect, and ε_{it} is an error term.[36]

---

[35] Dunne and Tian (2013) also demonstrates that the impact of military expenditure on growth is heterogeneous when countries are stratified into different income groups. In particular, the results illustrate negative and significant association for poorer countries, showing non-monotonic change in behaviour for higher income level economies (see also Dunne, 2012).

[36] The analysis employs a standard growth model with the introduction of military expenditure which is similar to the benchmark specification used by Aizenman and Glick (2006). As discussed in Dunne *et al.* (2005), taking into account the theoretical weaknesses generated by the Feder-Ram or Solow model, the extended Barro model used by Aizenman and Glick (2006) has comparative advantage to explain both military expenditure and growth. Here, the analysis does not purport to test these theoretical models; rather working in the tradition of cross-country growth literature, the investigation presents empirical evidence of the existence of a contingent relationship between growth and military expenditure.

As discussed in Caselli *et al.* (1996), the consistency of OLS estimators depends on the assumption that the country-specific effect ξ_i is orthogonal to other right-hand side variables. This assumption in growth regressions is clearly violated due to the presence of lagged income as an explanatory variable: i.e. $E[y_{i(t-1)}\xi_i] \neq 0$. Thus, a first step to achieve consistent estimates starts by eliminating the country-specific term.

One approach to eliminate ξ_i is using a fixed effects estimator that involves the implementation of a country-specific constant term. Another approach instead introduces the implementation of a country-specific random variable that is uncorrelated with the included regressors and may be realized using seemingly unrelated regression (SUR) (see Greene, 2003, for details regarding this estimator). These strategies deal successfully with estimation inconsistencies generated by non-orthogonality between explanatory variables and country-specific effects but, as Caselli *et al.* (1996) note, inconsistencies will continue to be problematic if the explanatory variables are not strictly exogenous.

To deal with inconsistency and likely endogeneity issues, Arellano and Bond (1991) proposed the GMM Difference estimator that is derived by taking first differences of all variables, and uses lagged levels of the explanatory variables as instruments. However, as discussed in Easterly and Levine (2001), the difference estimator has the statistical shortcoming that if regressors are persistent, then lagged levels of explanatory variables are weak instruments. Further, taking differences of the original level equation reduces the time dimension of the sample and leaves information about the level relationship between explanatory variables and growth unused. An additional complication associated with the estimation in differences involves potential measurement errors associated with the explanatory variables.[37]

To overcome these issues, Arellano and Bover (1995) and Blundell and Bond (1998) developed the System GMM estimator that combines the differenced model with the levels model. However, it should be noted that the move from the difference to the

[37] Hauk and Wacziarg (2004) have studied the impact of measurement error on the performance of the estimators discussed, explicitly in the context of the growth regressions. They conclude the following: In the presence of measurement error, fixed-effects and difference estimators tend to underestimate the coefficient of lagged income and parameter values associated with the additional explanatory variables. In contrast, the cross-sectional OLS estimator and the panel SUR estimator both tend to provide relatively accurate estimates of lagged income, while overestimating the magnitude of parameters associated with the additional explanatory variables.

systems estimator also involves a cost: the adoption of additional assumptions regarding orthogonality between the country-specific effect and the regressors, which are difficult to justify *a priori*.

Lacking clear guidance regarding the choice of estimators, the analysis follows Easterly and Levine (2001) (see also DeJong and Ripoll, 2006) and reports results obtained from several alternative estimators: cross-section OLS, SUR, Fixed effects, Difference and System GMM.[38] For the additional sensitivity analysis System GMM is the preferred estimator.

The treatment of each regressor according to their exogeneity levels under the GMM estimators is based on upper and lower bound conditions (Roodman, 2006).[39] To ensure that the estimated effect is not driven by the number of instruments, the analysis also employs the “1 lag restriction” technique followed by Roodman (2009) that uses only certain lags instead of all available lags as instruments.

Along with coefficient estimates obtained using GMM estimators, tables also report three tests of the validity of identifying assumptions they entail: Hansen’s (1982) test of over-identifying restrictions for the joint validity of moment conditions;[40] and Arellano and Bond’s (1991) AR(1) and AR(2) tests in first differences. AR (1) test is of the null hypothesis of no first-order serial correlation, which can be rejected under the identifying assumption that ε_{it} is not serially correlated; and AR (2) test is of the null hypothesis of no second-order serial correlation, which should not be rejected. In addition, to deal with heteroskedasticity, the Windmeijer (2005) small-sample correction is applied.

---

[38] In addition to these estimates, between-effects and random effects estimates were calculated but are not reported, because the between-effects estimator is closely related to the OLS estimator and the random-effects estimator is closely related to the SUR estimator, and therefore the results obtained using these additional estimators are quantitatively similar to those reported here. Moreover, the fixed-effects estimator and the difference GMM estimator leads to quantitatively similar results as well, however both estimators are reported since a large body of research analyses in the defence literature is based on these estimators.

[39] Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats military expenditure (and its interactions), and investment ratio as endogenous, while other variables employed in the specification as predetermined. For detailed information regarding upper and lower bound conditions, see also Appendix 2-A.

[40] It is of note that some of the Hansen test statistics during the analysis (especially when the investigation stratifies the data set into separate subsamples) yield high p-values (e.g., in excess of 0.90). This can be a warning signal that too many moment conditions are in use; and therefore, the results from these specifications must be read with caution.

As an additional robustness check, to identify potential outlier countries that might affect the estimation results, the analysis employs a strategy advocated by Belsley *et al.* (1980). It involves the application of the DFITS statistic to flag the countries associated with high combinations of residual and leverage statistics.

Turning to the method used to capture potential contingencies in the relationship between growth and military expenditure, two approaches are employed. Under the first, the baseline approach involves including in (3i) additional explanatory variable constructed as the product of military expenditure and log of initial income. The hypothesis is that the direct impact of military spending is negative, while marginal impact is increasing in income levels implying that the effect of military expenditure becomes less negative at higher levels of income. The second approach involves stratifying the data set into different subsamples; and separate specifications of (3i) are estimated, where growth linearly responds to the changes in military expenditure. Therefore four income groups are defined: high income (rank 4) countries; upper-middle income (rank 3) countries; lower-middle income (rank 2) countries; and low-income (rank 1) countries.[41] Analysis of these relationships demonstrates that evidence of a significant interaction term effect arises by monotonic changes in the impact of military expenditure on growth across different subsamples.

3.2.2. Data and Descriptive Statistics

The analysis is based on a balanced dynamic panel dataset that consists of 89 countries over the 1970-2010 period.[42] The panel dataset is constructed by transforming time series data into non-overlapping five year averages. This procedure smoothes out short-run cyclical fluctuations thereby helping the analysis to concentrate on long-run growth effects (Knight *et al.*, 1996). The dependent variable is logged per capita real (Laspeyres) GDP growth constructed using data

[41] The cut-off levels of income rankings are taken as in DeJong and Ripoll (2006), where country classifications are obtained by mapping classification thresholds as defined by the World Bank's income measures into the corresponding Penn World income measures. The resulting definitions are as follows: high-income level countries are those with real per capita GDP above $11,500; upper-middle income level countries those between $5,500 and $11,499; lower-middle income level countries are between $2,650 and $5,499; and low-income level countries those with less than $2,650. Note that the classifications during the analysis are based on 1970 income rankings.

[42] See Appendix Tables 3-A and 3-B for the list of countries and descriptive statistics.

from the Penn World Table (PWT 7.1). The log of initial income per capita is used as regressor.

Military spending is measured as the average ratio of military expenditures to GDP, using data collected from the SIPRI (Stockholm International Peace Research Institute) Yearbooks. As online data tables relate only to the period from 1988 onwards, military expenditure shares for the previous periods are collected and inputted directly from the SIPRI Yearbooks in order to extend the time horizon.[43]

Along with numerous advantages of having a longer time horizon, the access to military data before 1990 period allows an investigation of whether the ambiguous findings in the literature are driven by the changes in the nature of conflicts after the post-Cold War era. As discussed in Kaldor (1999), the end of proxy-wars and superpower involvement in local wars did not reduce the number of conflicts, but did reduce the intensity of military battles. There are fewer real military battles than in the past, but attacks on civilians increased showing a dominance of civil or intra-state conflict.

The investigation also uses a standard set of control variables typically employed in the empirical growth literature (e.g., Barro and Lee, 1994; Barro and Sala-i-Martin, 1995, Ch. 12). It includes two proxies for human capital: the log of average years of schooling attained by males aged 15 and over, obtained from the Barro and Lee data set, and the log of life expectancy, as reported by the United Nations; and also the population growth rate,[44] real private investment as a percentage of real GDP and degree of economic openness, all as reported in the Penn World Table (PWT 7.1).

Table 3-1 provides summary statistics for military expenditure share and growth over different income groups. Two aspects of these statistics are of particular interest in the analysis. The first is the tendency that relatively richer countries tend to enjoy

---

[43] Data on military spending were initially collected starting from the period of 1959 as the PWT data on real GDP per capita are not available for most countries before this date. However, given the trade off between having longer time series dimension and losing cross-country sample observations for which data on all variables are available, the analysis was constrained to the period of 1970 and onwards, yielding the balanced sample of 89 countries.

[44] Growth rate of population employed in the analysis is computed as log of $n + g + \delta$, where n is average population growth rate; g is the rate of technical progress and δ is the rate of depreciation of the stock of physical capital investment and $g + \delta$ is assumed to be equal to 0.05, following Mankiw *et al.* (1992).

relatively rapid growth. Average growth rates increase monotonically when moving from the lower to higher income classifications: from 1.473% (s.d. 2.136) for low-income countries to 2.095% (s.d. 0.442) for high-income countries. The second aspect of these statistics is that relatively rich countries tend to spend relatively more on the military sector. The average military expenditure share tends to increase when moving from the low to high income classifications (with the exception of the upper-middle income group): from 2.637% (s.d. 1.782) to 3.297% (s.d. 3.128).

3.3. Empirical Results

Figure 3-2 illustrates how the relationship between military spending and economic growth is contingent on the level of income. A positive relationship between growth and the interaction term indicates that the marginal impact of military expenditure on growth is increasing in initial income. In turn, military expenditure significantly decreases growth in the low- and lower-middle income subsample, while this effect is positive, albeit insignificant, in the upper-middle and high-income subsample. Taking the evidence from Figure 3-2 (see also Figure 3-1) as preliminary, it is of interest to confirm the presence of the contingency that these figures illustrate using more formal analysis.

Estimation results for the impact of military expenditure contingent on initial per capita income are presented in Tables 3-2 – 3-9. Table 3-2 reports the coefficient estimates from a non-linear estimation. Table 3-3 displays the estimation results using the alternative specification, where the relationship is estimated linearly using low-half and high-half income subsamples of the data. Table 3-4 runs the same exercise using the four income rankings, while Table 3-5 examines the linear relationship between growth and military spending for a relatively homogeneous group of countries. Table 3-6 and 3-7 examine the sensitivity of the estimates of the variables of interest to the presence in the data of several alternative subsets of countries, singled out for certain unusual aspects of their growth rate experiences and military expenditure shares. Table 3-8 exercises the contingency relationship for different time windows. Finally, Table 3-9 uses alternative measures for income and military spending as additional robustness check.

3.3.1. Military Spending and Growth Contingencies

While not reported in the tables, a discussion of the global relationship observed between military spending and growth excluding the military expenditure and initial income interaction term from the baseline specification is pertinent. Using the full sample, a moderate negative relationship is estimated, and the estimated impact on growth of a one percentage point increase in military expenditure is approximately -0.04 percentage points (the significance of the coefficient estimates exhibits sensitivity to the particular estimator being employed).

Inclusion of contingencies into the model, as reported in Table 3-2, demonstrates that the negative relationship is evident only among relatively poor countries, and a positive sign for the interaction term is obtained in all cases. In contrast to the cross-sectional OLS, panel estimators demonstrate significant impacts of both linear and non-linear terms in all cases when the outliers are removed.[45]

Splitting the data set into subsamples as reported in Table 3-3, one including low- and lower-middle income countries, the other including upper-middle and high-income countries, and estimating separate linear specifications for each yields results which are, in general, consistent with the findings from Table 3-2. For the low and lower-middle subsample, the military expenditure coefficients are all estimated as negative and in most cases significant. For the upper-middle and high-income subsample, a mixed picture emerges: the estimates oscillate between positive and negative values and rarely differ significantly from zero (in 8 cases out of 10).[46] Regarding quantitative significance, using the estimates produced by the System GMM estimator, the impact on growth of a one percentage point increase in military expenditure is estimated as -0.133 percentage points among low- and lower-middle income countries, and -0.002 percentage points among upper-middle and high-income countries.[47]

---

[45] Note that the joint validity test of the moment conditions is not satisfied for GMM difference (column b).

[46] Note that the second-order serial correlation condition for upper-middle and high-income subsample is not satisfied under the GMM Difference (column b) specification. Therefore, the model that delivers a valid estimate of a significant impact of military expenditure for the high-half subsample is only the fixed effects specification.

[47] These measures are obtained by dividing the coefficient estimates by the time span between income observations (5 years).

A similar picture emerges when the four income rankings are considered. There is a notable difference across the estimates when investigation moves from the poorest countries to the richest.[48] For the poorest countries, those with index values of 1, all fourteen sets of quantitative-significance estimates are negative, showing high significance in most cases. Regarding quantitative significance, using the estimates produced by the System GMM estimator (Panel B, column b in Table 3-4), the impact on growth of a one percentage point increase in military expenditure is estimated as -0.130 percentage points among the income rank 1 countries. This finding reveals that the significant impact from military spending for the low-half income distribution is mainly driven by the poorest economies. For the relatively richer countries, the impact of military expenditure becomes less and less negative, converging towards zero.[49]

In a further effort to investigate whether this heterogeneity for military spending effects is somehow different across infra-marginal changes throughout subsamples, Figure 3-3 plots the estimated coefficients of military expenditure along with their relative confidence bands (at 95% level) while income level is marginally increasing both within and across income subsamples throughout the entire income distribution. In order to do so, all observations are divided into different intervals depending on the value of logged income per capita, where each interval is selected so to maintain the similar distance between the lower and upper bounds for each interval. The resulting intervals are for the logged income per capita values [4.8, 5.8], [5, 6], [5.2, 6.2],…, [9.8, 10.8]. The results are supportive with the evidence above confirming monotonic increase in military spending effects when moving from lower to higher income level economies.

The results from splitting the countries into more homogeneous groups according to their economic and geographical characteristics, and estimating separate linear

---

48 The test of the equality of the military expenditure estimates for the poorest and the richest countries produced by the System GMM estimator (Panel B, column b in Table 3-4) rejects the null that the impact is the same.

49 For the richest countries in the world, the significance of military expenditure under GMM Difference is not robust when using the “1 lag restriction” technique. Therefore, the only estimator that demonstrates a significant impact of military expenditure is the fixed effects model out of the five estimators (see Panel B in Table 3-4). Note that this was also the case for high-half subsample in Table 3-3. This might suggest that some caution should be taken when employing the fixed effects or GMM Difference estimators in the military spending and growth analysis.

specifications for each group reveal essentially the same story. The negative effect of military spending is estimated to be wider, deeper and robustly significant for Sub-Saharan Africa (SSA) and Middle East and North Africa (MENA) countries (see also e.g., Smaldone, 2006; Hamid, 2012). Interestingly, it turns out that the elimination of Iran, Israel and Jordan from the MENA subsample alters the significance of the military expenditure estimates. This result can be explained by the high demand for security in these countries, and the non-linear impact of military spending when a country is faced with high threat (see Aizenman and Glick, 2006). Another interesting feature worth mentioning here is that a significant positive effect from military spending for East Asia and the Pacific region countries is driven by major arms producers like China and “Asian Tigers” countries, and becomes insignificant when these countries are removed from the subsample. Overall, these results demonstrate that the negative and significant impact from military expenditure across countries is mainly the case for the SSA and MENA regions where for the rest of the subgroups the results are mixed, with the estimates varying in sign and rarely demonstrating a robust significant impact.[50]

Thus, the results from Tables 3-3 – 3-5 imply that the contingency pattern from modelling military spending and growth as shown in Table 3-2 is robust and continues to hold under alternative sample splitting methodologies. All in all, these findings suggest that a negative and significant relationship is only apparent among poor economies, and illustrates a typically insignificant impact among relatively richer economies. Moreover, the behaviour of this pattern is monotonic in direction, converging towards zero for sufficiently high income level countries, which therefore explains the ambiguity in findings from previous research.

Coefficient estimates of additional explanatory variables enter mostly with the expected signs. Estimated coefficients on lagged income and the investment ratio are, respectively, negative and positive, statistically significant, and typically indicate strong quantitative effects. Life expectancy also exhibits a strong relationship with growth. The negative impact of trade openness is mainly driven by low-half income distribution countries, where a positive sign is apparent only among

[50] The estimated impact of military expenditure does not differ significantly from zero in 11 cases out of 14 for Advanced Economies and East Asia and Pacific; and in 12 cases for Latin America and Caribbean subsample.

upper-middle and high-income countries (see also DeJong and Ripoll, 2006). Surprisingly, schooling exhibits a negative relationship with growth when an interaction term is employed; but this effect disappears when alternative sample splitting strategies are considered. Finally, the estimated effect of population growth is mostly negative and typically insignificant.

3.3.2. Robustness Checks

Beyond the robustness checks as described above, special attention is paid to the potential influence on the results of several subsets of countries. The first collection of subsets features countries singled out on the basis of certain unusual aspects of their growth rate experiences during the time period spanned by the sample. Results of this exercise are reported in Table 3-6 for three subsets of countries. For each subset, Table 3-6 reports the list of countries, their 1970 and 2005 income rankings, their average military expenditure shares and growth rates measured over the entire sample period, and the coefficient estimates obtained for military spending and its interaction with initial income given their removal from the sample in addition to outlier countries. Only estimates obtained using System GMM are reported, but the general flavour of the exercise is consistent across estimators. For ease of comparison, the estimates obtained given the exclusion of the four outlier countries, as in Table 3-2 (column b), are also reported. The additional subsets of countries singled out on the basis of unusual aspects of their growth rate experiences include the twelve escapees from the low-income group, the sixteen escapees from the low and lower-middle income group, and the Asian Tigers.[51]

Strikingly, the coefficient estimates change very little given the removal of any one of the subsets under consideration; and in all cases, enter significantly at conventional levels. For both the linear and non-linear terms of military expenditure, the estimates obtained given the removal of each subsample lie within one standard deviation of the full-sample estimate.

[51] It is of note that exclusion of countries on the basis of their realized growth experiences might be problematic for the estimation analysis since the composition of the sample then becomes dependent on realizations of the error term. Although this concern is acknowledged, the purpose of this exercise here is, by working in the tradition of cross-country growth literature, to present empirical evidence that the existence of a contingent relationship between growth and military expenditure is not driven by a small number of exceptional countries.

The second collection of subsets includes countries singled out due to the maintenance of high shares of military expenditure in addition to outlier countries. Three subsets are considered: the two low-income and the two high-income countries with the highest military expenditure shares specified as those with military spending levels above the top decile; and the union of these two subsets. The impact of removing these subsets of countries is reported in Table 3-7. Once again, point estimates change very little. What does change somewhat is statistical significance in the case when the second and third subsets are excluded. However, the general pattern of results reported in Table 3-2 remains apparent given the exclusion of these countries from the sample.

Collectively, the results from Tables 3-6 and 3-7 suggest that the contingent relationship between growth and military expenditure does not seem attributable to the influence of a small number of exceptional countries.

Using time effects in all regressions controls for any common factor that could affect all countries in any five-year interval. However, it is of interest to check if the results hold when different time windows are used for the estimation. A sensitive issue is that the post-Cold War era led to important changes in the nature of conflicts by reducing the intensity of real military battles than in the past, and whether these changes from the period after the end of Cold-War alter the results (Kaldor, 1999). The baseline time span in the analysis is 1970-2010. Table 3-8 considers more restrictive information available for three successive periods of minimum 20 years: 1970-1995; 1980-2010; 1990-2010. The result holds significantly in the first and third periods but not in the second (significant only at 18% level), suggesting that the findings of a contingent relationship between military expenditure and growth are also robust when the analysis is restricted to the post-Cold War era. Overall, the general pattern of results reported in Table 3-2 remains apparent under alternative restrictions of the dataset to different time windows.

Table 3-9 presents the robustness test using alternative income and military expenditure measures. As discussed in Johnson *et al.* (2013), using PWT income data can be problematic and affect cross-country growth estimates because of variability across different versions of the PWT. Although using low-frequency data is robust to these inconsistencies in data revisions, as a check on results, column 1 employs GDP per capita from the World Development Indicators (WDI) as an alternative income measure. Column 2 instead uses an alternative approach to capture potential contingencies in the relationship between growth and military spending by replacing the product of lagged income and military expenditure with an alternative one: the product of military expenditure and 1970 income rankings which takes values 1 (for the poorest income countries) to 4 (for the richest countries). Column 3 employs the World Bank data as an alternative source for military expenditure share instead of SIPRI.[52] In all three cases, the main results hold.[53]

Overall, the sensitivity results provide supportive evidence of a contingent relationship between growth and military expenditure conditional on initial income levels.

3.4. Conclusion

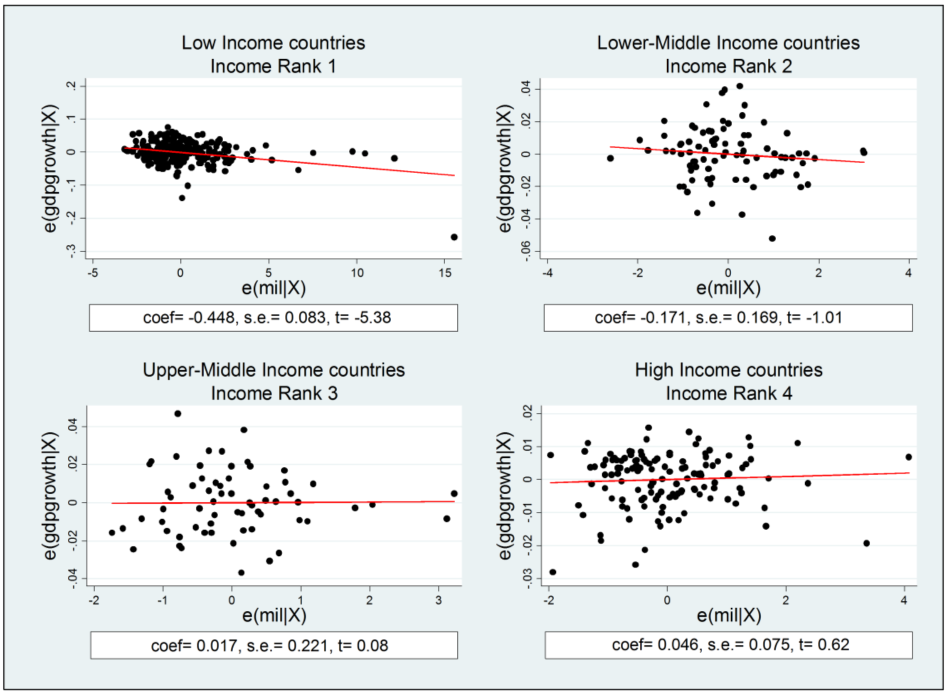
The empirical analysis shed light on the rationale behind ambiguous outcomes from previous research by reassessing the relationship between growth and military spending contingent on a country's economic development level. The findings have revealed the presence of a significant interaction effect under which the marginal impact of military expenditure on growth is increasing in initial income. In particular, investigation finds that while growth falls with higher levels of military spending among the world's poor countries, the impact of military expenditure on growth becomes less and less negative as a country becomes richer, and this contingency pattern is monotonic in direction, going towards zero for less budgetary constrained countries.

The analysis suggests a number of paths for future research concerning the effect of military activity on economic growth through income. A particularly promising avenue of future research would be to analyze the role of the existence of a defence industry in a country. Specifically, it is of interest to see whether the difference in the impact of military expenditure across income groups is driven by trade in arms,

[52] Note that employing the World Bank measure of military expenditure share restricts the data set to 1990-2010 period.
[53] A separate linear relationship of military expenditure and growth is also estimated using WDI income data for low-half and high-half income subsamples and four income rankings. The results are qualitatively similar to that presented here.

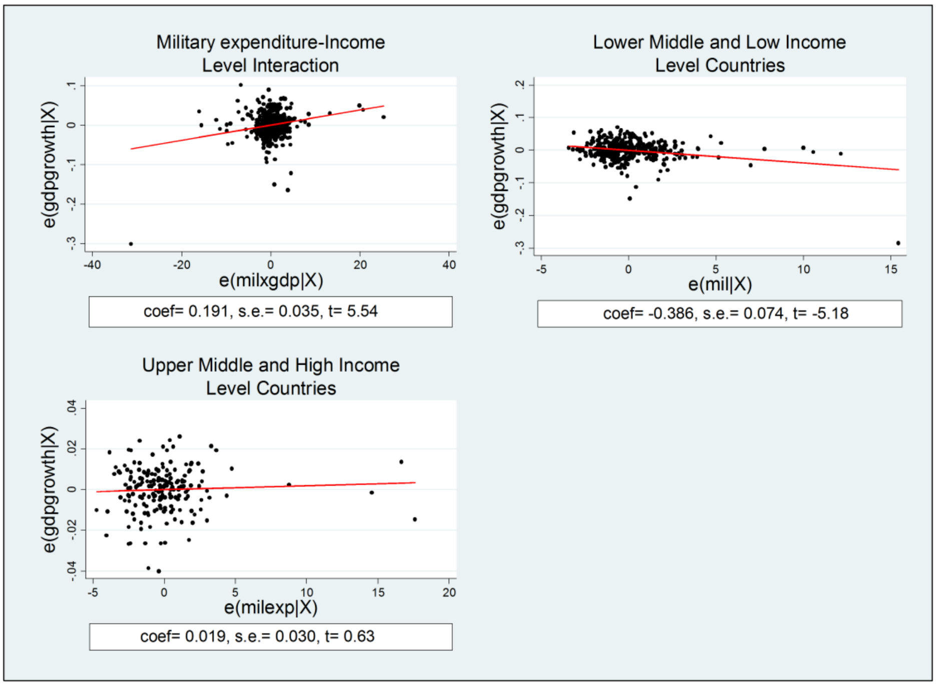
including exports of military production, which might offset the detrimental impact of military expenditure by attracting export revenues.

Figure 3-1: Partial Regression Plots for Military Expenditure and Growth



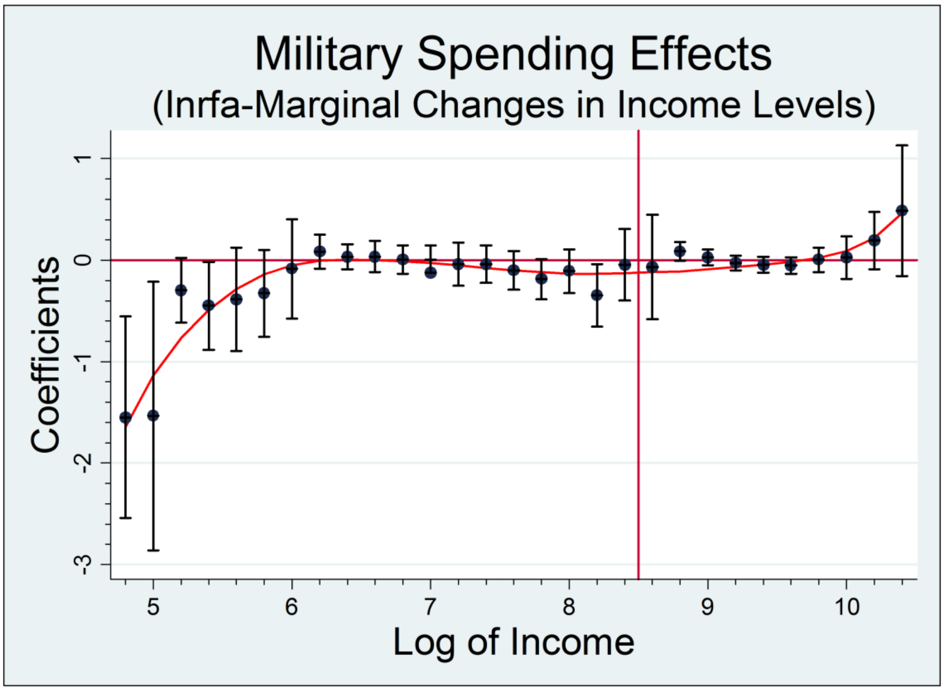
Note: The set of regressors includes log of initial income, log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. The figures are produced using OLS panel regressions, excluding outliers as defined in Table 3-4.

Figure 3-2: Partial Regression Plots for Military Expenditure and Growth



Note: The set of regressors includes log of initial income, growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. Partial regression plot for interaction term also includes military expenditure into specification. The figures are produced using OLS panel regressions, excluding outliers as defined in Tables 3-2 and 3-3.

Figure 3-3: Military Expenditure Effects by Infra-Marginal Changes in Income Levels



Note: The graph plots the estimated impact of military spending on growth conditional on infra-marginal changes in income levels. The infra-marginal intervals are selected so to maintain the same distance between the lower and upper bounds for each interval. The set of regressors also includes log of initial income, growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. Black spikes represent 95% confidence bands; the vertical line corresponds to the threshold line between low and high-half income level countries. Red line represents local polynomial smoothed trend for the impact of military spending on growth when moving from lower to higher income categories. The method of estimation is the panel least squares with robust standard errors.

Table 3-1: Descriptive Statistics for Growth and Military Expenditure

Summary Statistics						
Sample split	Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Full sample	Mil. exp.	89	2.789	2.189	0.281	14.964
	Growth	89	1.730	1.709	-5.338	6.900
Low income	Mil. exp.	44	2.637	1.782	0.281	9.049
	Growth	44	1.473	2.136	-5.338	6.900
Lower-middle	Mil. exp.	16	3.026	2.385	0.933	11.247
	Growth	16	1.787	1.427	-0.678	5.467
Upper-middle	Mil. exp.	11	2.219	1.526	0.364	4.693
	Growth	11	2.078	1.425	0.502	5.272
High income	Mil. exp.	18	3.297	3.128	1.067	14.964
	Growth	18	2.095	0.442	1.086	2.798
Lower Mid./Low	Mil. exp.	60	2.740	1.947	0.281	11.247
	Growth	60	1.557	1.965	-5.338	6.900
High/Upper-Mid.	Mil. exp.	29	2.888	2.656	0.364	14.964
	Growth	29	2.089	0.918	0.502	5.272

Note: All descriptive statistics are based on cross country averages for the 1970-2010 period.

Table 3-2

Non-linear Specifications of Military Expenditure

Dependent Variable: Log difference of real GDP per capita (Laspeyres)

	OLS		**SUR**		**Fixed effects**		**Difference GMM**		**System GMM**	
	a	b	a	b	a	b	a	b	a	b
Initial GDP p.c. (log)	-0.003	-0.004	-0.010***	-0.011***	-0.029***	-0.029***	-0.044**	-0.051	-0.016***	-0.021***
	(0.004)	(0.003)	(0.002)	(0.002)	(0.004)	(0.005)	(0.018)	(0.037)	(0.005)	(0.006)
Mil. exp/GDP	**-0.354**	**-0.505**	**-1.396*****	**-1.816*****	**-2.199*****	**-2.649*****	**-1.282**	**-1.782***	**-2.094**	**-3.021****
	(0.572)	**(0.430)**	**(0.269)**	**(0.294)**	**(0.376)**	**(0.398)**	**(0.788)**	**(0.895)**	**(1.446)**	**(1.444)**
							[0.107]		**[0.151]**	
Mil*GDP	**0.038**	**0.053**	**0.149*****	**0.191*****	**0.243*****	**0.286*****	**0.135**	**0.177***	**0.225**	**0.322****
	(0.060)	**(0.045)**	**(0.032)**	**(0.034)**	**(0.049)**	**(0.050)**	**(0.090)**	**(0.099)**	**(0.161)**	**(0.157)**
							[0.138]		**[0.164]**	
Pop. growth (log)	-0.016	-0.021*	-0.003	-0.005	0.013	0.012	-0.003	0.008	-0.019	-0.032***
	(0.015)	(0.011)	(0.007)	(0.007)	(0.008)	(0.008)	(0.017)	(0.022)	(0.012)	(0.012)
Life expectancy (log)	0.069**	0.073***	0.093***	0.093***	0.055***	0.052**	0.090	0.042	0.130***	0.166***
	(0.027)	(0.019)	(0.012)	(0.013)	(0.019)	(0.021)	(0.072)	(0.106)	(0.040)	(0.058)
Investment/GDP	0.082***	0.052***	0.106***	0.094***	0.161***	0.162***	0.152***	0.132**	0.248***	0.251***
	(0.029)	(0.019)	(0.013)	(0.013)	(0.019)	(0.019)	(0.039)	(0.051)	(0.047)	(0.056)
Openness (log)	-0.002	-0.003	-0.007***	-0.008***	-0.011**	-0.015***	-0.008	-0.007	-0.014*	-0.023**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)	(0.004)	(0.014)	(0.015)	(0.007)	(0.009)
Schooling (log)	-0.009*	-0.010**	-0.008**	-0.007**	-0.020**	-0.017*	-0.039*	-0.036	-0.006	-0.020*
	(0.005)	(0.004)	(0.003)	(0.003)	(0.009)	(0.009)	(0.021)	(0.025)	(0.007)	(0.011)
Countries/Observations	89/89	85/85	89/695	85/665	89/695	85/665	89/601	85/575	89/695	85/665
SPECIFICATION TESTS (*p* -values)										
(a) Hansen Test:							0.772	0.025	0.897	0.986
(b) Serial Correlation:										
First-order							0.008	0.075	0.000	0.001
Second-order							0.247	0.191	0.492	0.387

Note: Columns "a" estimate military expenditure and economic growth relationship for the full sample, while columns "b" estimate the same specification removing outliers. All estimated results for GMM estimators are achieved using the "1 lag restriction" technique following Roodman (2009). The excluded countries are Botswana, China, Egypt and Singapore. The outliers are singled out using OLS regressions. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses; the estimates in square brackets are p-values.

Table 3-3
Low-half and High-half Income Sample Splits
Dependent Variable: Log difference of real GDP per capita (Laspeyres)

	OLS		**SUR**		**Fixed effects**		**Difference GMM**		**System GMM**	
	a	b	a	b	a	b	a	b	a	b
Panel A: Upper-middle and High Income Sample										
Initial GDP p.c. (log)	0.001	-0.004	-0.007**	-0.008**	-0.039***	-0.049***	-0.032	-0.064**	-0.008	-0.015*
	(0.005)	(0.006)	(0.003)	(0.004)	(0.009)	(0.009)	(0.028)	(0.023)	(0.006)	(0.008)
Military exp/GDP	**-0.001**	**0.047**	**-0.006**	**0.019**	**-0.088**	**-0.101***	**-0.161**	**-0.106****	**-0.011**	**-0.012**
	(0.046)	**(0.033)**	**(0.043)**	**(0.030)**	**(0.090)**	**(0.057)**	**(0.104)**	**(0.044)**	**(0.036)**	**(0.050)**
Pop. growth (log)	-0.009	-0.029**	-0.022**	-0.034***	0.0002	-0.023	0.035	0.008	-0.031**	-0.066**
	(0.014)	(0.011)	(0.009)	(0.008)	(0.021)	(0.018)	(0.036)	(0.038)	(0.015)	(0.025)
Life expectancy (log)	0.053***	0.088	0.116***	0.121***	0.149***	-0.052	0.067	-0.339	0.121***	0.279**
	(0.018)	(0.059)	(0.029)	(0.043)	(0.056)	(0.078)	(0.152)	(0.332)	(0.026)	(0.123)
Investment/GDP	0.107***	0.032	0.111***	0.107***	0.048	0.188***	0.028	0.195***	0.161**	0.320***
	(0.034)	(0.039)	(0.025)	(0.022)	(0.040)	(0.031)	(0.026)	(0.065)	(0.066)	(0.051)
Openness (log)	0.003	-0.002	0.003	-0.003	0.009	0.004	0.028	0.011	0.005	-0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.007)	(0.005)	(0.026)	(0.015)	(0.007)	(0.009)
Schooling (log)	0.003	0.002	0.005	0.006	-0.011	-0.015	0.008	-0.008	0.006	0.006
	(0.008)	(0.007)	(0.007)	(0.005)	(0.014)	(0.010)	(0.039)	(0.018)	(0.009)	(0.016)
Countries/Observations	29/29	23/23	29/232	23/184	29/232	23/184	29/203	23/161	29/232	23/184
(a) Hansen Test:							0.980	1.000	0.995	0.720
(b) Serial Correlation: *First-order*							0.002	0.156	0.086	0.059
Second order							0.153	0.011	0.446	0.069
Panel B: Lower-middle and Low Income Sample										
Initial GDP p.c. (log)	0.002	-0.001	-0.004*	-0.005**	-0.019***	-0.012**	-0.050**	-0.009	-0.007**	-0.018**
	(0.004)	(0.004)	(0.002)	(0.002)	(0.005)	(0.005)	(0.019)	(0.036)	(0.003)	(0.007)
Military exp/GDP	**-0.054**	**-0.099**	**-0.262*****	**-0.385*****	**-0.414*****	**-0.606*****	**-0.386****	**-0.698****	**-0.324**	**-0.665***
	(0.112)	**(0.104)**	**(0.056)**	**(0.074)**	**(0.074)**	**(0.104)**	**(0.180)**	**(0.300)**	**(0.209)**	**(0.341)**
									[0.126]	
Pop. growth (log)	-0.035	-0.041	0.006	0.039***	0.024**	0.059***	0.017	0.008	0.004	0.029
	(0.024)	(0.030)	(0.008)	(0.013)	(0.010)	(0.017)	(0.017)	(0.038)	(0.018)	(0.044)
Life expectancy (log)	0.065**	0.092***	0.089***	0.133***	0.034	0.065**	0.005	0.021	0.105***	0.236***
	(0.029)	(0.032)	(0.015)	(0.017)	(0.024)	(0.027)	(0.075)	(0.101)	(0.030)	(0.054)
Investment/GDP	0.069**	0.069***	0.111***	0.113***	0.169***	0.161***	0.168***	0.193***	0.142***	0.196***
	(0.030)	(0.024)	(0.015)	(0.016)	(0.024)	(0.025)	(0.047)	(0.055)	(0.035)	(0.051)
Openness (log)	-0.005	-0.005	-0.012***	-0.014***	-0.016***	-0.018***	-0.005	-0.029	-0.013**	-0.015*
	(0.004)	(0.004)	(0.003)	(0.003)	(0.005)	(0.006)	(0.014)	(0.017)	(0.005)	(0.009)
Schooling (log)	-0.011**	-0.012**	-0.007	-0.006	-0.013	-0.004	-0.029	0.009	-0.008	-0.015
	(0.005)	(0.006)	(0.004)	(0.004)	(0.012)	(0.013)	(0.024)	(0.028)	(0.007)	(0.011)
Countries/Observations	60/60	52/52	60/463	52/401	60/463	52/401	60/398	52/344	60/463	52/401
(a) Hansen Test:							0.995	0.270	0.994	0.996
(b) Serial Correlation: *First-order*							0.001	0.005	0.001	0.003
Second order							0.740	0.419	0.520	0.669

Note: Columns "a" and "b" estimate military expenditure and economic growth relationship, respectively, with and without outliers. The estimated results for GMM estimators are achieved using the "1 lag restriction" technique following Roodman (2009). Eliminated countries from high-half income group are Argentina, Cyprus, Ireland, Iran, Mexico and Singapore, while for low-half income sub-sample are Botswana, Egypt, Guyana, Jordan, Mozambique, Rwanda, Sierra Leone and Zambia. The outliers are singled out using OLS regressions. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses; the estimates in square brackets are p-values.

Table 3-4
Sample Splits for Income Rankings
Dependent Variable: Log difference of real GDP per capita (Laspeyres)

Panel A: Measures of Quantitative Significance

Income Group	OLS	SUR	Fixed effects	Difference GMM		System GMM	
				a	b	a	b
Rank 1	-0.013	-0.249***	-0.484***	-0.426*	-0.326**	-0.237	-0.187
	(0.116)	(0.069)	(0.088)	(0.236)	(0.152)	(0.242)	(0.332)
Rank 2	-0.069	-0.186**	0.026	0.024	-0.194	-0.169	-0.157
	(0.061)	(0.092)	(0.136)	(0.177)	(0.164)	(0.100)	(0.096)
Rank 3	0.065	-0.181	-0.266	-0.209	0.337	-0.181	-0.181
	(0.424)	(0.215)	(0.349)	(0.282)	(0.416)	(0.234)	(0.234)
Rank 4	0.006	-0.035	-0.073	-0.084*	-0.038	-0.033	-0.027
	(0.037)	(0.028)	(0.046)	(0.044)	(0.081)	(0.032)	(0.032)

Panel B: Measures of Quantitative Significance, Outliers Removed

Income Group	OLS	SUR	Fixed effects	Difference GMM		System GMM	
				a	b	a	b
Rank 1	-0.117	-0.448***	-0.697***	-0.670	-0.799*	-0.473*	-0.651*
	(0.131)	(0.082)	(0.123)	(0.410)	(0.428)	(0.277)	(0.323)
				[0.111]			
Rank 2	0.185	-0.171	-0.048	-0.048	-0.117	-0.171	-0.171
	(0.196)	(0.168)	(0.214)	(0.247)	(0.481)	(0.119)	(0.118)
Rank 3	0.569	0.017	-0.071	-0.071	0.208	0.017	0.017
	(0.231)	(0.218)	(0.354)	(0.178)	(0.249)	(0.232)	(0.232)
Rank 4	0.117	0.046	-0.399**	-0.356*	-0.194	0.052	0.065
	(0.083)	(0.074)	(0.170)	(0.181)	(0.239)	(0.102)	(0.104)

Note: Columns "a" under the GMM specifications estimate military expenditure and economic growth relationship using all possible lags, while the results in columns "b" are achieved using the "1 lag restriction" technique following Roodman (2009). All specifications employ log of initial income, growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The excluded countries from income rank 1 sample are Egypt, Guyana, Mozambique, Rwanda, Sierra Leone and Zambia; from income rank 2 are Brazil, Jordan, Korea Rep, Nicaragua and Panama; from income rank 3 are Cyprus, Iran and Mexico; from income rank 4 are Israel and Norway. The outliers are singled out using OLS regressions. The number of countries/observations in Panel A are 44/44 for OLS, 44/335 for SUR, FE and GMM System and 44/286 for GMM Difference in income rank 1 sample; 16/16, 16/128 and 16/112 in income rank 2 sample; 11/11, 11/88 and 11/77 in income rank 3 sample; 18/18, 18/144 and 18/126 in income rank 4 sample. The respective figures for Panel B are 38/38, 38/288 and 38/245 in income rank 1; 11/11, 11/88 and 11/77 in income rank 2; 8/8, 8/64 and 8/56 in income rank 3; 16/16, 16/128 and 16/112 in income rank 4. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses; the estimates in square brackets are p-values.

Table 3-5
Sample Splits for Different Types of Economies
Dependent Variable: Log difference of real GDP per capita (Laspeyres)

Panel A

Estimates of Military Expenditure for Different Types of Economies

Type of Economy	OLS	SUR	Fixed effects	Difference GMM		System GMM	
				a	b	a	b
Advanced	0.122	0.076	-0.155	-0.145	-0.206	0.088	0.099
Economies	(0.106)	(0.080)	(0.172)	(0.161)	(0.239)	(0.097)	(0.119)
Latin America	0.009	-0.312**	-0.265	-0.226	-0.337	-0.287	-0.474*
and Caribbean	(0.250)	(0.154)	(0.214)	(0.453)	(0.443)	(0.202)	(0.227)
Sub-Saharan	0.108	-0.712***	-1.059***	-1.083**	-0.854*	-0.728	-0.959**
Africa	(0.263)	(0.131)	(0.151)	(0.379)	(0.458)	(0.427)	(0.458)
						[0.101]	
East Asia and	-1.181	0.501***	0.447	0.447	0.208	0.501**	0.501**
the Pacific	(1.795)	(0.192)	(0.294)	(0.283)	(0.294)	(0.200)	(0.200)
Middle East &	0.168**	-0.078	-0.171	-0.171	-0.149	-0.078	-0.078
North Africa	(0.003)	(0.076)	(0.123)	(0.124)	(0.133)	(0.056)	(0.056)

Panel B

Estimates of Military Expenditure for Different Types of Economies, Outliers Removed

Type of Economy	OLS	SUR	Fixed effects	Difference GMM		System GMM	
				a	b	a	b
Advanced	0.132	0.081	-0.394**	-0.371**	-0.627*	0.089	0.097
Economies	(0.094)	(0.076)	(0.172)	(0.139)	(0.305)	(0.114)	(0.129)
Latin America	0.053	-0.147	-0.256	-0.253	-0.116	-0.148	-0.148
and Caribbean	(0.268)	(0.129)	(0.187)	(0.171)	(0.372)	(0.153)	(0.154)
Sub-Saharan	-0.069	-1.193***	-1.420***	-1.538***	-1.768***	-1.202***	-1.331***
Africa	(0.395)	(0.158)	(0.177)	(0.188)	(0.230)	(0.277)	(0.228)
East Asia and	1.881	0.279	0.249	0.249	0.249	0.279	0.279
the Pacific	(0.375)	(0.179)	(0.346)	(0.352)	(0.352)	(0.235)	(0.235)
Middle East &	0.063	-0.218**	-0.213*	-0.213***	-0.213***	-0.218***	-0.218***
North Africa	(0.146)	(0.090)	(0.107)	(0.047)	(0.047)	(0.053)	(0.053)

Note: Columns "a" under the GMM specifications estimate military expenditure and economic growth relationship using all possible lags, while the results in columns "b" are achieved using the "1 lag restriction" technique following Roodman (2009). All specifications employ log of initial income, growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The excluded countries from Advanced Economies sample are Spain, Ireland and Portugal; from Latin America and the Caribbean sample - Brazil, Guyana, Nicaragua, Panama and Paraguay; from Sub-Saharan Africa sample - Botswana, Mozambique, Mauritania, Rwanda, Sierra Leone and Zambia; from East Asia and the Pacific sample - China, Indonesia, Korea Rep and Papua New Guinea; from Middle East and North Africa sample - Iran, Israel and Jordan. The outliers are singled out using OLS regressions. The number of countries/observations in Panel A are 20/20 for OLS, 20/160 for SUR, FE and GMM System and 20/140 for GMM Difference in Advanced Economies sample; 19/19, 19/151 and 19/131 in Latin America and Caribbean sample; 26/26, 26/195 and 26/165 in Sub-Saharan Africa sample; 9/9, 9/69 and 9/60 in East Asia and the Pacific sample; 9/9, 9/69 and 9/63 in Middle East and North Africa sample. The respective figures for Panel B are 17/17, 17/136 and 17/119 in Advanced Economies sample; 14/14, 14/111 and 14/96 in Latin America and Caribbean sample; 20/20, 20/149 and 20/125 in Sub-Saharan Africa sample; 8/8, 8/40 and 8/35 in East Asia and the Pacific sample; 7/7, 7/48 and 7/42 in Middle East and North Africa sample. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses; the estimates in square brackets are p-values.

Table 3-6
Upward Movers and Asian Tigers
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	Income Rank, 1970	Income Rank, 2005	Average Mil. Exp. Share	Average Growth Rate	Coeff.	S. E.	p value
Remove Outliers							
Botswana	1	3	3.32	5.75		**Mil.exp/GDP**	
China	1	2	1.73	6.90	-3.021	1.444	0.039
Egypt	1	2	8.66	3.03		**Mil*GDP**	
Singapore	3	4	4.61	5.27	0.322	0.157	0.044
Remove Escapees from Low Income Group							
Fiji	1	2	1.25	1.99			
Guyana	1	2	2.76	2.54			
Honduras	1	2	1.50	1.04			
Indonesia	1	2	2.34	4.19			
Malaysia	1	3	3.73	4.01		**Mil.exp/GDP**	
Mauritius	1	3	0.28	2.87	-3.101	1.457	0.037
Morocco	1	2	4.10	2.38		**Mil*GDP**	
Paraguay	1	2	1.35	1.44	0.331	0.157	0.039
Sri Lanka	1	2	2.52	3.70			
Syria	1	2	9.05	1.48			
Thailand	1	3	2.88	4.46			
Tunisia	1	2	2.10	2.60			
Remove Escapees from Low and Lower-Middle Income Group							
Algeria	2	3	2.57	1.28			
Brazil	2	3	1.52	2.29			
Chile	2	3	4.16	2.29			
Colombia	2	3	2.31	2.39			
Ecuador	2	3	2.19	1.77			
El Salvador	2	3	1.79	0.99			
Guatemala	2	3	1.13	1.51		**Mil.exp/GDP**	
Korea Rep.	2	4	3.85	5.47	-2.708	1.524	0.080
Malaysia	1	3	3.73	4.01		**Mil*GDP**	
Mauritius	1	3	0.28	2.87	0.287	0.164	0.085
Panama	2	3	0.93	3.47			
Peru	2	3	3.05	1.28			
South Africa	2	3	2.63	1.38			
Thailand	1	3	2.88	4.46			
Turkey	2	3	4.01	2.51			
Uruguay	2	3	2.11	2.20			
Remove Asian Tigers							
Indonesia	1	2	2.34	4.19		**Mil.exp/GDP**	
Korea Rep.	2	4	3.85	5.47	-2.955	1.544	0.059
Malaysia	1	3	3.73	4.01		**Mil*GDP**	
Thailand	1	3	2.88	4.46	0.318	0.169	0.063

Note: The estimation results are achieved using the "1 lag restriction" technique following Roodman (2009). All specifications employ log of initial income, growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The number of countries/observations for each panel is, respectively, 85/665, 73/570, 69/537 and 81/633. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8).

Table 3-7
Exclusion of Countries with High Military Expenditure Shares
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	Income Rank, 1970	Income Rank, 2005	Average Mil. Exp. Share	Average Growth Rate	Coeff.	S. E.	p value
Remove Outliers							
Botswana	1	3	3.32	5.75		**Mil.exp/GDP**	
China	1	2	1.73	6.90	-3.021	1.444	0.039
Egypt	1	2	8.66	3.03		**Mil*GDP**	
Singapore	3	4	4.61	5.27	0.321	0.157	0.044
Remove High Military Exp. Share, Low Income Countries							
Egypt	1	2	8.66	3.03		**Mil.exp/GDP**	
					-3.027	1.523	0.050
Syria	1	2	9.05	1.48		**Mil*GDP**	
					0.321	0.164	0.053
Remove High Military Exp. Share, High Income Countries							
Israel	4	4	14.96	2.42		**Mil.exp/GDP**	
					-3.476	1.984	0.083
United States	4	4	5.37	1.68		**Mil*GDP**	
					0.401	0.241	0.100
Remove All Subsets							
Egypt	1	2	8.66	3.03		**Mil.exp/GDP**	
Syria	1	2	9.05	1.48	-3.369	1.871	0.075
Israel	4	4	14.96	2.42		**Mil*GDP**	
United States	4	4	5.37	1.68	0.375	0.225	0.099

Note: The estimation results are achieved using the “1 lag restriction” technique following Roodman (2009). All specifications employ log of initial income, growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The number of countries/observations for each panel is, respectively, 85/665, 83/649, 83/649 and 82/641. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8).

Table 3-8
Different Time Windows
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	1970-1995 (1)	1980-2010 (2)	1990-2010 (3)
Initial GDP p.c. (log)	-0.028***	-0.018***	-0.019**
	(0.009)	(0.006)	(0.007)
Mil. exp/GDP	**-4.381*** **	**-2.217**	**-3.216** **
	(1.637)	**(1.564)**	**(1.439)**
		[0.160]	
Mil*GDP	**0.486** **	**0.241**	**0.338** **
	(0.189)	**(0.176)**	**(0.156)**
		[0.174]	
Control Set	Yes	Yes	Yes
Countries/Observations	89/431	89/614	89/439
SPECIFICATION TESTS (*p* -values)			
(a) Hansen Test:	0.352	0.926	0.230
(b) Serial Correlation:			
First-order	0.031	0.000	0.001
Second-order	0.767	0.554	0.874

Note: The estimation results are achieved using the "1 lag restriction" technique following Roodman (2009). Additional control set includes growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. The time series dimension (T) for columns 1-3 is, respectively, 5, 6 and 4. ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses; the estimates in square brackets are p-values.

Table 3-9
Alternative Data Sources and Measurements
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	(1)	(2)	(3)
Initial GDP p.c. (log)	-0.010**	-0.043**	-0.014*
	(0.004)	(0.018)	(0.008)
Mil. exp/GDP	**-2.725** **	**-0.470** **	**-5.666*** **
	(1.136)	**(0.183)**	**(1.409)**
Mil*GDP	**0.386** **		**0.624*** **
	(0.168)		**(0.182)**
Mil*Rank		**0.117** **	
		(0.052)	
Control Set	Yes	Yes	Yes
Countries/Observations	89/688	89/601	89/342
SPECIFICATION TESTS (*p* -values)			
(a) Hansen Test:	0.971	0.796	0.142
(b) Serial Correlation:			
First-order	0.000	0.015	0.000
Second-order	0.695	0.260	0.536

Note: The estimation results under the columns 1 and 3 are achieved using System GMM; while under the column 2 Difference GMM is used. In addition, column 1 and 3 also employs the "1 lag restriction" technique following Roodman (2009). Additional control set includes growth rate of population, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. The time span for the analysis in columns 1 and 2 is based on balanced dataset for the 1970-2010 period (T=8), while in column 3 for the 1990-2010 period (T=4). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

4. Externalities in Military Spending and Growth: The Role of Natural Resources as a Channel through Conflict

4.1. Introduction

The economic effects of military spending continue to be the subject of considerable debate in the literature where the impact of military expenditure is frequently found either to be non-significant or negative.[54] How do these effects vary across economies? And what factors drive the heterogeneity of military spending effects? These questions continue to be an important focus for research as it is an expenditure by governments that has influence beyond the resources it takes up, especially when countries need some level of security to deal with internal and external threats generating positive externalities for the military spending and growth relationship.

This analysis reproduces many of the results of the existing literature using a large panel dataset which employs a large dataset on military spending and variety of conflict measures. The investigation shows that the differential impact of military expenditure is increasing and significant not only for external threat levels, but also internal threat levels. In addition, extending the concept of the resource-conflict link, the analysis contributes to the defence literature by showing that the impact of military expenditure on growth is less detrimental for countries with large natural resource wealth once corruption levels are accounted for. The analysis also addresses the concerns from the resource-conflict literature regarding endogenous behaviour of resource rents share measurement, with findings that suggest a significant positive impact of natural resource wealth on conflict.

There is a widely held view that political tensions and associated high levels of military spending are likely to undermine a country's economic growth prospects. As discussed in Knight *et al.* (1996), while political tensions induced by domestic and foreign threats themselves can have detrimental impact on a country's economic performance, there are direct and interrelated avenues by which sustained increases in military spending may negatively influence economic growth. For instance, increases in military spending may reduce the efficiency of allocation of resources

[54] For surveys of the military spending and growth literature see Chan (1987), Dunne (1996, chap. 23), Smith (2000), Ram (2003), Smaldone (2006), Dunne and Uye (2009).

available for alternative domestic uses such as investment in (public and private) productive capital, education, health and market-oriented technological innovation, and hence adversely affect an economy's growth prospects. On the other hand, military sector can also yield a "peace dividend" in the form of stability by improving efficiency in countering both external and internal security threats, and deliver an environment for productive activities which will feed back in the economy as higher levels of long-run growth.

In any event, theoretical literature has allowed the identification of a number of channels through which military spending can impact the economy – such as labour, capital, technology, external relations, socio-political effects, debt and conflicts (see Dunne and Uye, 2009). The relative importance and sign of these effects, as well as the overall impact on growth can only be ascertained by empirical analysis.

An important issue acknowledged in the empirical literature is the identification problem that results from the feature that security threats may influence observed changes in both military spending and economic growth. Aizenman and Glick (2006) explain the presence of these non-linearities showing that, while growth falls with higher levels of military spending, its impact is positive in the presence of external threats.

Another feature that has emerged in the conflict literature is the role of natural resources.[55] Collier and Hoeffler (1998) offered a pioneering empirical contribution finding that resource wealth has a positive impact on possibility of conflict, with the main results robust to employing alternative measures of resource wealth (notably a measure of resource rents, see Collier and Hoeffler, 2005).

Although the resource-conflict link is increasingly viewed as a stylized fact in economics and political science (see e.g., Ross 2004a; Ron, 2005), the explanations

[55] The literature has distinguished between no fewer than three different dimensions of the "resource curse": resources are associated with (i) slower economic growth, (ii) violent civil conflict, (iii) undemocratic regime types. Selected contributions include the following works: On economic growth, refer to Sachs and Warner (1995), Mehlum *et al.* (2006), Brunnschweiler and Bulte (2008) and etc. With respect to conflict, refer to Collier and Hoeffler (1998, 2004), Ross (2004a, b), De Soysa and Neumayer (2007), Collier *et al*. (2009), Lujala (2009). Considering regime type (and institutions more broadly), refer to Ross (2001), Leite and Weidmann (2002), Jensen and Wantchekon (2004), Bulte *et al*. (2005) and Caselli and Tesei (2011). Overview articles include Rosser (2006), Dixon (2009) and van der Ploeg (2009).

of this evidence are mixed. Focussing on the economic roots of conflict, De Soysa (2002), Fearon (2005), Ross (2006), De Soysa and Neumayer (2007), and Lujala (2009) highlight the role of (legal) oil and mineral resource trading. An increased probability of foreign intervention (Rosser, 2006) and the probability of suffering from economic shocks (Collier and Hoeffler, 2005) are other explanations as to why resources might be linked to conflict.

Other explanations of the resource-conflict link arise around political (state-strength) perspectives of (potential) rebels as key decision-makers (e.g., Auty, 2004; Dunning, 2005; Humpreys, 2005; Snyder and Bhavnani, 2005). According to this view, resource-rich economies tend to suffer from a weak state and an unaccountable leadership, which is unable or unwilling to diversify the economy in order to deliver key public goods. Alternatively, resource riches may encourage oppressive regimes, leading to genuine grievances amongst a share of the population.[56]

Therefore there are many reasons to believe that high levels of resource wealth may generate high demand for military protection since the military performs as a premium guard against the internal and external risk that a country may face. In addition, having natural resources can also reduce the opportunity costs of increasing military spending and building up the military–industrial complex to strengthen the ability of the military to protect national security and natural resources (Ali *et al.*, 2013; Dunne and Tian, 2013).

Considering the various mechanisms mentioned, it is not always straightforward to distinguish how resources are related to conflict. On one hand, while the income from resource abundance may serve as an incentive for rebellion activity, one may also argue that it proxies for the "effectiveness of the state" (e.g., Fearon and Laitin, 2003). Along with these complications, there is a literature that involves resource scarcity, rather than abundance, as a driver of violent conflict (Homer-Dixon, 1999;

[56] Standard explanations of civil war advanced by economists and political scientists are greed and grievance. The rational choice concept regards civil war as a special form of non-cooperative behaviour. The greed motive simply reflects a chance for rebels to enrich themselves; grievance, however, is explained in a behavioural context, and underlines relative deprivation, social discrimination and inequality (e.g., due to ethnic and religious segregations, see Regan, 2003). Ballantine (2003) has emphasized that the mix of greed and grievance can be particularly effective and relevant as an explanation of the onset of war. Ross (2004b) investigates these motives, along with other potential conflict triggers. The theoretical foundation of these perspectives may be traced back to Grossman (1991) and Hirshleifer (1995).

Brunnschweiler and Bulte, 2009). Another concern in the literature is that resource rents, as in Collier and Hoeffler (2005) and De Soysa and Neumayer (2007), may be endogenous with respect to conflict.

The remainder of the paper is organized as follows. The methodology and data employed are described in Section 4.2. Section 4.3 presents the estimation results and Section 4.4 concludes.

4.2.1. Empirical Methodology

The analysis employs the System GMM dynamic panel estimator by Arellano and Bover (1995) and Blundell and Bond (1998), which builds on the GMM Difference estimator developed by Arellano and Bond (1991). This approach can be used to address the issues of potential biases induced by country specific effects, and of joint endogeneity of all explanatory variables in a dynamic formulation which is especially important here because of the link between military spending and conflict, i.e. if military expenditure is reacting to an increased threat of conflict, then the ultimate cause of the reduced growth might be the threat of conflict itself rather than the observed military expenditure. Moreover, to ensure that the estimated effect is not driven by the number of instruments, the analysis employs the "1 lag restriction" technique introduced by Roodman (2009) that uses only certain lags instead of all available lags as instruments. The treatment of each regressor according to their exogeneity levels is based on upper and lower bound conditions (Roodman, 2006).[57]

Along with coefficient estimates obtained using System GMM estimator, the tables also report three tests of the validity of identifying assumptions they entail: Hansen's (1982) test of over-identifying restrictions for the joint validity of the moment conditions;[58] and Arellano and Bond's (1991) AR(1) and AR(2) tests in first differences. AR (1) test is of the null hypothesis of no first-order serial correlation, which can be rejected under the identifying assumption that error term is not serially

[57] Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats military expenditure, natural resources, conflict, corruption (and all interactions with military expenditure), and investment ratio as endogenous, while other variables employed in the specification as predetermined. For detailed information regarding upper and lower bound conditions, see also Appendix 2-A.

[58] It is of note that some of the Hansen test statistics during the analysis yield high p-values (e.g., in excess of 0.90). This can be a warning signal that too many moment conditions are in use; and therefore, the results from these specifications must be read with caution.

correlated; and AR (2) test is of the null hypothesis of no second-order serial correlation, which should not be rejected. In addition, to deal with heteroskedasticity, the Windmeijer (2005) small-sample correction is applied.

The benchmark analysis follows a similar specification used by Aizenman and Glick (2006) which provides evidence of a non-linear growth effect of military expenditure, which allows the presence of threats to security.[59] Starting from this benchmark, the analysis confirms the presence of conflict risks and government performance as potential sources of positive externalities for the relationship between growth and military spending, and then looks at the interaction between military expenditure and natural resources as a channel through conflict, also accounting for the potential adverse effect that might be generated by poor governance, namely by rent-seeking or corruption activities.

Letting the subscripts *i* and *t* represent country and time period respectively, the estimated model can be written as

$$y_{it} - y_{i(t-1)} = \alpha\, y_{i(t-1)} + \theta_1 mil_{it} + \theta_2 mil_{it} * X_{it} + \varphi' X_{it} + \beta' Z_{it} + \mu_t + \xi_i + \varepsilon_{it} \qquad (4i)$$

where y is log of real per capita income, mil_{it} is military spending, X_{it} is the vector of variables interacted with military spending expressed as either threat, corruption or natural resource wealth, Z_{it} is a vector of additional control variables, μ_t is a period-specific constant, ξ_i is an unobserved country-specific effect, and ε_{it} is an error term.

The hypothesis is that $\theta_1 < 0$ and $\theta_2 > 0$ implying that the impact of military expenditure $\theta_1 + \theta_2 * X_{it}$ is less negative at high levels of threat, government performance and natural resource wealth. Moreover, as θ_1 and θ_2 have opposite signs, a threshold effect arises:

$$\frac{\delta(y_{it} - y_{i(t-1)})}{\delta\, mil_{it}} = \theta_1 + \theta_2 * X_{it} > 0 \quad \xrightarrow{yields} \quad X_{it} > \quad \tilde{X} := -\frac{\theta 1}{\theta 2}$$

[59] Dunne *et al.* (2005) in their critical review paper compare theoretical models mainly employed by defence economists. They conclude that the Feder-Ram model should be avoided within the defence economics literature, since it is prone to theoretical misinterpretation. The augmented Solow model used by Knight *et al.* (1996) has fewer theoretical weaknesses, but it is too narrow given the range of variables that have been found significant determinants of growth. The reformulation of the Barro model used by Aizenman and Glick (2006), which allows for security effects on output is more promising and has the comparative advantage to explain both military expenditures and output.

The standard errors of the respective threshold levels are computed using the delta method. However it is of note that in small samples, the delta method is known to result in excessively large standard errors.

As an additional robustness check, outliers are singled out using a strategy advocated by Belsley *et al.* (1980) that involves the application of the DFITS statistic to identify the countries associated with high combinations of residual and leverage statistics.

4.2.2. Data and Descriptive Statistics

The initial analysis is based on a balanced dynamic panel dataset consisting of 89 countries over the 1970-2010 period.[60] To construct the panel dataset, non-overlapping five year intervals are used. This filters out short-run cyclical fluctuations, so that the analysis can focus on long-run growth effects (Aghion *et al.*, 2009). The dependent variable, logged per capita real (Laspeyres) GDP growth, is constructed using data from the Penn World Table (PWT 7.1). The log of initial income per capita is used as regressor.

Military spending is measured as the average ratio of military expenditures to GDP, using data collected from the SIPRI (Stockholm International Peace Research Institute) Yearbooks. As online data tables relate only to the period from 1988 onwards, military expenditure shares for the previous periods are collected and inputted directly from the SIPRI Yearbooks in order to extend the time horizon.[61]

The degree of threat measure employed is twofold: internal and external. To measure the internal threat level, the analysis employs two alternative proxies: internal conflict onset and internal conflict incidence. The former is measured as the fitted values of civil conflict onset from Fearon and Laitin (2003). The projection of probabilities for onset is realized according to the specification of their original

---

[60] See Appendix Tables 4-B and 4-C for the list of countries and descriptive statistics.

[61] Data on military spending was initially collected for 173 countries starting from the period of 1959 as the PWT data on real GDP per capita is not available for most countries before this date. However, the time horizon was restricted to the period of 1970 and onwards because the measure of natural resources is available only since this date. Moreover, in order to maximise the number of countries for which data on military expenditure and real GDP per capita is available for most years, the balanced sample was limited to 113 countries. Due to lack of the data for other important control variables, the analysis was further constrained to the balanced sample of 89 countries.

paper.[62] The latter is constructed using UCDP/PRIO Armed Conflicts 2012 Dataset of the International Peace Research Institute's (PRIO) Centre and Uppsala Conflict Data Program (UCDP), and computed by counting the number of internal threat incidences during non-overlapping five year intervals for the period of 1970-2010. A country's external threat level is proxied in two ways. First, a war intensity measure is computed in a similiar way as in Aizenman and Glick (2006) by counting the number of wars a country has been involved in conflict for the last half century. Specifically, it is defined as the number of years a country was at war with each of its adversaries during the period from 1960 to 2010 and divided by the sample period. This variable is constructed based on the data of militarized interstate disputes from "Major Episodes of Political Violence, 2008" collected by the University of Maryland's Center for Systematic Peace (CSP). A sensitive issue from the estimation of military expenditure and growth relationship conditional on a war intensity measure is that the estimated effect might be driven by the future conflict that a country has not experienced yet at previous time period. Therefore, the analysis also employs an alternative measure of external threat incidence which is constructed using UCDP/PRIO data; and computed by counting the number of wars a country has been involved in conflict during non-overlapping five year intervals for the period of 1970-2010.

The measure of resource wealth is based on data on resource rents provided by Hamilton and Ruta from the World Bank.[63] It includes two categories of natural resources: minerals and energy (oil, gas and coal); and is measured as the product of the quantity of resources extracted and the difference between the resource price and the unit cost of extraction.

Corruption is measured by the control of corruption index extracted from ICRG (International Country Risk Guide) data set.[64] The index has values ranging from a value of 0 (for very high corruption or very poor performance) to 6 (for very low

[62] More specifically, the predicted values of civil conflict onset from model 2 of Table 1 as in Fearon and Laitin (2003) are used. The projection reflects prior war, income, population, mountains and non-contiguous territory, oil, new states and political instability, polity2, as well as ethnic and religious fraction. Note that employing the civil conflict onset measure restricts the data set to 1970-2000 period.

[63] See also Collier and Hoeffler (2005), De Soysa and Neumayer (2007).

[64] Employing corruption data restricts the sample to 82 countries and the time span to the period of 1985-2010.

corruption or excellent performance) and hence may be interpreted as an increasing index of government performance.

To examine the claim of endogenous behaviour of resource rents measurement for the resource-conflict analysis, several variables are employed to serve as exogenous instruments. Instrumental variables should be exogenous and correlated with the 1st stage endogenous variables, but not with the error term of the 2nd stage conflict regression. The instruments employed include three geographical variables – distance to major navigable river,[65] percentage of fertile soil (*soil*), and percentage of land area in the tropics (*tropics*).[66] It is evident that biophysical conditions can affect a country's comparative advantage in exporting primary commodities, and hence its resource dependence. Moreover, there is no indication that these instruments invite conflict directly and therefore correlate with the 2nd stage error term.[67]

A further instrument is given by the variable *democracy* constructed by replacing negative values of the variable *polity2* in the Polity IV database (Marshall, 2010) with zero. *Polity2* is widely used in the empirical political-science literature as a measure of the position of a country on a continuum of autocracy-democracy spectrum (e.g., Acemoglu *et al.*, 2008; Persson and Tabellini, 2006, 2009; Besley and Kudamatsu, 2008). Although one might question the exogeneity of regime type for conflict regressions, the analysis clearly demonstrates that this variable may be used as an instrument (see also e.g., Fearon and Laitin, 2003; Vreeland, 2008). There is also little reason to suspect that democratic system of governance leads to more incidents of civil conflict; and more importantly it is questionable whether it has a direct effect on conflict potential.[68]

---

[65] This variable is employed from G-Econ data set collected by Yale University. Source: http://gecon.yale.edu/data-and-documentation-g-econ-project

[66] The geographical characteristics on *soil* and *tropics* are obtained from Nunn and Puga (2012). Source: http://diegopuga.org/data/rugged/

[67] The geophysical characteristics most commonly found to influence conflict is the degree of high terrain, which is not directly linked to these geographical instruments.

[68] Using the *polity2* measure that ranges from -10 to 10, Fearon and Laitin (2003) find an insignificant impact of political regime type on civil conflict onset. However they suggest that anocracies, as defined by the middle of the Polity index (ranging from -5 to 5) of political regime, are more susceptible to civil conflict than either pure democracies or pure dictatorships. Unpacking the anocracy measure, Vreeland (2008) finds that certain components of the Polity index are defined with explicit reference to civil conflict, and when these components are removed from the Polity index, the significant relationship between political regime and conflict disappears. To check whether the

The analysis also employs a standard set of control variables typically used in the empirical growth literature (e.g., Barro and Lee, 1994; Barro and Sala-i-Martin, 1995, Ch. 12), which can be classified as stock and flow variables. Stock variables are measured at the beginning of each half decade and consist of two proxies for human capital: the log of average years of schooling attained by males aged 15 and over, obtained from the Barro and Lee data set; and the log of life expectancy, as reported by the United Nations. Flow variables are measured as averages over the half-decade. These feature the population growth rate,[69] real private investment as a percentage of real GDP and degree of economic openness, all as reported in the Penn World Table (PWT 7.1).

Table 4-1 provides summary statistics for shares of military expenditure and natural resources, and the cumulative incidence of conflict over the different subsamples. Three features are of note for the analysis. The first is the tendency that countries experience internal threat on average eight times more frequently than external threat (8.382 vs. 1.112). This supports the claim that the end of proxy-wars and superpower involvement in local wars did not reduce the number of conflicts in general, but did reduce the intensity of inter-state military battles (Kaldor, 1999). There are fewer real military battles than in the past, but attacks on civilians increased showing a dominance of civil or intra-state wars. Furthermore, over 2/3 of the sample never experienced any external threat, while this figure is almost the same for those who have experienced internal conflict. This might affect the economic impact of military expenditure on growth through external and internal conflict. The second facet of these statistics is that conflicts occur more frequently in relatively more resource abundant countries. The average natural resource shares increases when moving from the sample without any conflict experience to the sample with some conflict experience: from 2.391% (4.099%) to 5.608% (5.057%) for internal (external) threat. The third aspect is the obvious tendency that countries facing either external or internal threat tend to spend relatively more on the military sector compared with the

---

arguments above alter the results, the analysis also used a dummy for democracy that takes value of 1 if *polity2* is higher than 5 and 0 otherwise as an instrument. The results are qualitatively similar to that presented here.

[69] Growth rate of population employed in the analysis is computed as log of $n + g + \delta$, where n is average population growth rate; g is the rate of technical progress and δ is the rate of depreciation of the stock of physical capital investment and $g + \delta$ is assumed to be equal to 0.05, following Mankiw *et al.* (1992).

sample facing no threat. Average military expenditure share increases when moving from the sample without any conflict experience to the sample with some conflict experience: from 2.479% (2.242%) to 2.980% (4.112%) for internal (external) threat.

4.3. Empirical Results

Estimation results for the impact of military expenditure conditional on threat levels are presented in Table 4-2. Table 4-3 displays estimation results for the relationship between growth and military spending conditional on corruption levels. Tables 4-4 – 4-11 explore the relationship between growth and military spending concentrating on natural resources as a channel through conflict. Table 4-4 addresses the concerns of potential endogeneity problems in the resource-conflict relationship. The results from the non-linear estimation of the relationship between growth and military spending conditional on natural resource wealth are reported in Table 4-5. The subsequent tables report a number of sensitivity checks on the results from Table 4-5. In particular, the analysis explores the robustness of the results to: alternative criteria for inclusion of the countries in the sample based on (i) importance of the shares from natural resource rents in the economy; (ii) dropping large commodity producers and (iii) subsets of countries with relatively intense conflict experiences that might potentially be induced by resource abundance; (iv) breaking down the resource wealth by commodity type (energy and oil resources); (v) alternative time windows; (vi) allowance for other non-linearities.

4.3.1. Military Expenditure and Growth: Threats

Figure 4-1 illustrates how the impact of military spending on economic growth changes while the level of threat increases. Scatter plots and fitted relationships between the variables of interest are achieved using partial regressions.[70] The plots indicate a significant negative impact of military expenditure on growth for the sample with no experience of conflict, while this effect is positive, albeit insignificant, for the sample with some conflict experience.

[70] Partial-regression estimates are obtained in two stages. First, both the dependent variable and the isolated independent variable are projected onto the additional set of regressors under consideration. Next, the residuals of the dependent variable are regressed against the residuals of the independent variable. The figures are produced using OLS regressions where growth and military expenditure are related linearly.

Estimation results for the impact of military expenditure conditional on internal threat levels are presented in Table 4-2.[71] The conjecture of this investigation follows the idea that the impact of military expenditure on growth is a non-linear function of the effective militarized threat posed by internal and external forces. Alternatively, threats without expenditure for military security reduce growth, military expenditure without threats decreases growth, while impact of military expenditure in the presence of sufficiently large threats would be positive.

The results from the non-linear estimation of these relationships provide support for the conjecture, and indicate that military expenditure has a negative direct effect on growth. The coefficients on the interaction term are significant and positive in all cases, implying a positive marginal impact of military expenditure in the presence of threats. The coefficient estimates on threat measures are mostly negative where significances show sensitivity across different specifications. The threshold analysis for the internal threat measure of civil conflict onset implies that military spending has an overall negative (positive) effect on growth for threat levels below (above) the probability level of 0.032.

As a check on the results, the growth equation is re-estimated according to the threshold levels where the separate linear specifications are estimated for the subsamples below and above the threshold level.[72] The associated quantitative significance of a one standard deviation increase in military expenditure from splitting the data set into subsamples is estimated as -0.28 percentage points (significant) among low threat level countries, and -0.01 percentage points (insignificant) among high threat level countries.[73] Thus, these piece-wise linear specifications imply a relationship similar to that found in the specification that includes the interaction term between military expenditure and threat.

---

[71] An analogous analysis of the relationship between growth and military expenditure conditional on external threat levels is reported in Appendix Table 4-A1. Overall the results confirm the findings from Aizenman and Glick (2006) and demonstrate that this non-linearity is also apparent in a panel setting.

[72] The threshold value of 0.021 is used for the analysis of low and high internal threat sample. However note that any threshold value below 0.021 yields qualitatively similar results to that presented in Table 4-2.

[73] These measures are obtained by multiplying the coefficient estimate by average standard deviation of 2.81, dividing by the time span between income observations (5 years), and then multiplying by 100 to convert to a percentage-point measurement.

The last column in Table 4-2 employs alternative measure for internal threat levels using UCDP/PRIO data. The results are qualitatively similar and consistent with that found above.

Coefficient estimates of additional explanatory variables enter mostly with the expected signs. Initial income exhibits a negative relationship with growth. Estimated coefficients on life expectancy and the investment ratio are positive, statistically significant, and typically indicate strong quantitative effects. Finally, the estimated effects of population growth, trade openness and schooling are typically insignificant.

As an additional robustness check, the analysis also considered the potential influence of several subsets of countries singled out due to the maintenance of high shares of military expenditure and on the basis of certain unusual aspects of their conflict experiences during the time period spanned by the sample.[74] Results of this exercise are reported in Appendix Tables 4-A2 and 4-A3 where the results provide supportive evidence for the non-linear relationship conditional on threat levels as described above.

Overall, these findings suggest that the negative and significant relationship between military expenditure and growth is only apparent among countries facing low threats, while in the presence of sufficiently high threats military expenditure is not significantly detrimental for growth, illustrating typically an insignificant impact.

4.3.2. Military Expenditure and Growth: Corruption

Previous studies suggest that the relationship between growth and military expenditure also depends on corruption and rent seeking behaviour (see e.g., Gupta *et al.*, 2001; d'Agostino *et al.*, 2012). In Table 4-3, this association is examined more formally, where the hypothesis is that military expenditure in the presence of corruption (better government performance) reduces (increases) growth.

The results from the non-linear estimation of this relationship support this hypothesis. Military expenditure and corruption are decreasing economic performance directly, while the interaction term enters positively, all illustrating a

[74] See Appendix 4-A for description of additional robustness checks.

significant impact on growth. The associated quantitative significance of a one standard deviation increase in military expenditure from splitting the data set into subsamples according to the threshold level is estimated as -0.67 percentage points (significant) among high corruption level countries (those below the corruption level of 4.5), and 0.01 percentage points (insignificant) among low corruption level countries (those above the level of 4.5).

As noted by Delavallade (2005), the existence of corruption leads to a reallocation of resources from more productive sectors towards less productive ones. As military spending generates more rents, projects in this sector are likely to involve larger amounts of money and may attract more and larger bribes. Overall, the magnitude of these results implies that corruption leads to increases in military spending, worsening the negative impact of the larger military sector on the economy's growth rate.

4.3.3.1. Military Expenditure and Growth: Natural Resources

The exploration now turns to relationships between growth and military spending concentrating on natural resources as a channel through conflict. As mentioned previously, a large body of the literature identifies natural resource wealth as a major determinant of civil conflict. The dominant causal link is that resources provide finance and motive (the "state prize" model). Others see natural resources as causing "political Dutch disease" or increasing rent-seeking and corruption activities, which in turn weaken state capacity inducing failures in delivering key public goods and hence increase the likelihood of conflict. If this is the case, the resource-conflict link is expected to impact the military spending and growth relationship. This investigation supposes that if resource wealth leads to a higher risk of conflict, then the impact of military expenditure on growth is a non-linear function of natural resource wealth. In particular, the impact of military expenditure in the presence of a sufficiently large resource wealth would be positive, conditioning that natural resources are not associated with high corruption activities.

Estimation results of the analysis of the resource-conflict link are presented in Table 4-4. The first two columns of the upper panel derives this relationship using ordinary least squares (OLS) where civil conflict onset linearly responds to initial income, natural resources and the set of control variables as employed in the benchmark analysis. The findings are very similar to those found in the existing literature, where all variables of interest take the expected signs. Specifically, resource wealth leads to a higher probability of conflict, while a negative correlation is apparent for initial income. In both cases, initial income and resource wealth illustrate strong quantitative effects on probability of conflict onset.

In light of the concerns about endogeneity, as argued by Brunnschweiler and Bulte (2009), the next column applies a two-step instrumental variables (IV) model, where initial income and natural resources are estimated in the first stage by a simple linear regression, and the second stage uses an instrumental variable approach to determine the probability of the conflict onset. First-stage regression results, as shown in the lower panel, demonstrate that the instruments are strong. The joint endogeneity test from the linear estimation provide support for the idea that the variables of interest are jointly endogenous, and that instrumenting for these variables is necessary to obtain consistent estimates of the causal relationship for the onset of conflict.[75] The test statistics for the instruments, namely the over-identification test and the tests on the excluded instruments (all performed in linear regressions), also confirm that the instruments are strong and appropriate for the analysis.[76]

The estimation results from the instrumental variables approach imply a qualitatively similar relationship to that found in the OLS specifications. Higher incomes attenuate the risk of conflict, while resource wealth is positively and significantly associated with civil conflict onset. Therefore, returning back to the relationship of growth and military spending conditional on resource wealth, the effect from military expenditure and resource interaction is expected to be positive.

The results from the non-linear estimation of this relationship are reported in Table 4-5. To deal with problems that might potentially be induced from association of corruption with natural resources and military expenditure, the analysis employs two approaches (see e.g., Leite and Weidmann, 2002; Aizenman and Glick, 2006; d'Agostino *et al.*, 2012). Under the first, as shown in columns (1) and (2), the

[75] Separate endogeneity tests for the variables of interest fail to reject the exogeneity of initial income. However, natural resource wealth still enters endogenously. Therefore, the IV equation is also re-estimated by instrumenting only for natural resources; the results are qualitatively similar to that presented in Table 4-4.

[76] The joint significance test of the instruments fails to reject the null of no explanatory power on conflict.

specification also includes corruption and its interaction with military expenditure in addition to the interaction term between military expenditure and natural resources. Under the second (column 3), the growth equation is estimated by interacting military expenditure with two separate natural resource variables: one for resource wealth for those countries below the corruption level of 4.5 (high corruption), and the other for countries above this level (low corruption).

The estimation results from these alternative approaches provide support for the supposition. While military expenditure has a direct significant and negative effect on growth, the coefficients on the interaction terms with natural resources are positive, implying a positive differential impact of military expenditure. In particular, interaction terms under the first approach are significant and robust to the elimination of outliers. For the second approach, military expenditure is only significant for the case when it is interacted with resource wealth for countries with low corruption levels, and illustrates an insignificant impact for high corruption levels, confirming the concerns regarding a potential contradictory effect induced by corruption.

In summary, the findings confirm the idea that resource wealth is associated with a higher risk of conflict, and show that the impact of military expenditure in the presence of sufficiently large resource wealth is positive once corruption levels are accounted for.

4.3.3.2. Robustness Checks

Table 4-6 examines the robustness of the results estimated for the relationship between growth and military spending, conditional on natural resources, to the exclusion of countries whose natural resource wealth accounts for only a small share of GDP. For these countries it is unlikely that the capacity of resources provides finance or motive to induce a potential conflict, so focussing on a smaller sample with significant resource rents share is arguably a better test for sensitivity of the results. Columns 1 and 2 exclude countries in the first decile of the average share distribution (8 countries); columns 3 and 4 exclude countries in the first quartile (18 countries); and columns 5 and 6 exclude all countries below the median average share (39 countries). Results from baseline sample are confirmed and generally reinforced as the threshold to be included in the sample progressively increases. In particular, the point estimates for the interaction term (columns 2, 4 and 6) become more positive as the analysis focuses on more resource dependent countries.

The potential influence on the results of several additional subsets of countries is also considered. The collection of these subsets reflects countries singled out due to their resource dependence and conflict experiences during the time period spanned by the sample. The results of this exercise are illustrated in Tables 4-7 and 4-8. For each subset, Tables 4-7 and 4-8 report the list of countries, their average shares of natural resource rents, military expenditure and growth rates measured over the entire sample period, and the coefficient estimates obtained for interaction terms of military spending with natural resources as specified above for the first and the second approach.

Table 4-7 addresses the plausible concern that high stakes from resource rents might incentivise conflict potential and affect motivation for rebels to enrich themselves. The investigation therefore excludes from the sample four subsets of countries: (i) those belonging to OPEC; (ii) big oil and natural gas producers; (iii) large minerals and coal producers; and (iv) the union of these subsets.[77] In all cases, the results remain robust at least at the 10% significance level with coefficient estimates of the variables of interest lying within one standard deviation of the full-sample estimate.

Table 4-8 checks the sensitivity of the results to the exclusion of countries with relatively intense conflict experiences that might potentially be induced by resource wealth. The results of this exercise are demonstrated for three subsets of countries: (i) countries with high internal threat levels and high natural resource shares specified as those experienced internal threat above the mean of cumulative internal conflict incidence and with natural resource levels above the mean; (ii) countries with high external threat levels and high natural resource shares defined as those experienced external threat more than approximately one standard deviation from the mean of cumulative external conflict incidence and with natural resource levels

[77] The investigation treats Indonesia as an OPEC country, as it belonged to the organisation for more than half of the sample period. It also includes Ecuador who joined the OPEC in 2007. Alternative treatments of these countries do not alter the results. Big commodity producers reflect countries with more than 3% of total world supply, belonging to the list of top 10 biggest producers (according to the latest estimates) in the world by commodity. Data for commodities produced in a country are obtained from the following sources: minerals from British Geological Survey 2000-2008; Oil, natural gas and coal from US Energy Information Administration 1980-2009.

above the mean; and (iii) the union of these subsets. The coefficient estimates of the interaction terms change very little given the removal of any one of the subsets under consideration. However, statistical significance of the interaction term, as specified under the first approach, is somewhat altered in the case when the exclusion of the second and the third subsets is employed. Overall, the general pattern of results reported in Table 4-5 remains apparent given the exclusion of these countries from the sample.

Table 4-9 deals with the issue of commodity typology. An important distinction that has been made in the literature is the role of energy and oil trading as a potential driver of conflict (Rosser, 2006; De Soysa and Neumayer, 2007 and etc.), which is believed to induce higher risk of conflict, as these commodity types are generally more valuable and easier to control for the ruling elite. Therefore columns 1-2 and 3-4 break down the resource wealth into energy and oil resources respectively. The results from both cases are consistent with findings from Table 4-5. Furthermore, the point estimates of interaction terms provide support to the belief that energy and oil resources in particular, are the crucial drivers of the impact of the natural resources on the conflict potential as mentioned above.

Using time effects in all regressions controls for any common factor that could affect all countries in any five-year interval. In addition, the non-linear specification implicitly allows for time and cross-country variation in the effect of military expenditure on economic growth. However, it would be of interest to check if the results hold when different time windows are used for the estimation. The baseline time span in the analysis for natural resource contingency is 1985-2010. Table 4-10 considers more restrictive information under the first approach available for four successive periods of minimum 15 years: 1985-2000; 1985-2005; 1990-2010; 1995-2010. The result holds significantly, at least at the 10% significance level, suggesting that the findings from non-linear relationship between growth and military expenditure are also robust when the analysis is restricted to different time spans.

A final robustness check explores the sensitivity of the results to the inclusion of additional non-linearities of military expenditure. Results of this exercise are reported in Table 4-11 where columns 1 and 2 add the interactions of military expenditure, respectively, with initial logged income and the threat measure of conflict onset into the specification.[78] In all cases, the results remain robust. Moreover, note that all other interactions show a highly significant impact and take the correct sign.[79]

Overall, the findings provide supportive evidence to the general pattern of results reported in Table 4-5 showing robust relationship between growth and military expenditure conditional on natural resource wealth.

4.4. Conclusion

The empirical analysis has confirmed that military expenditure in the presence of high external threats increases economic growth, while military expenditure driven by rent seeking and corruption reduces growth. In addition, the analysis provides evidence that such non-linearity is also apparent when internal threats are considered. Extending the concept of the resource-conflict link, the analysis also contributes to the defence literature showing that military expenditure is less detrimental for countries with large natural resource wealth as long as the resource wealth is not associated with high corruption activities.

The empirical research was constrained by the limited availability of data for some countries (e.g., for Arab Gulf countries, former Soviet Union countries), inducing the analysis to concentrate on a relatively limited country sample. Therefore there is no obvious way to deal with the robustness constraints imposed by the limitations of the sample. Hence, the results should be taken as a suggestive of the deeper structure linking military expenditure, conflict, natural resource wealth and growth.

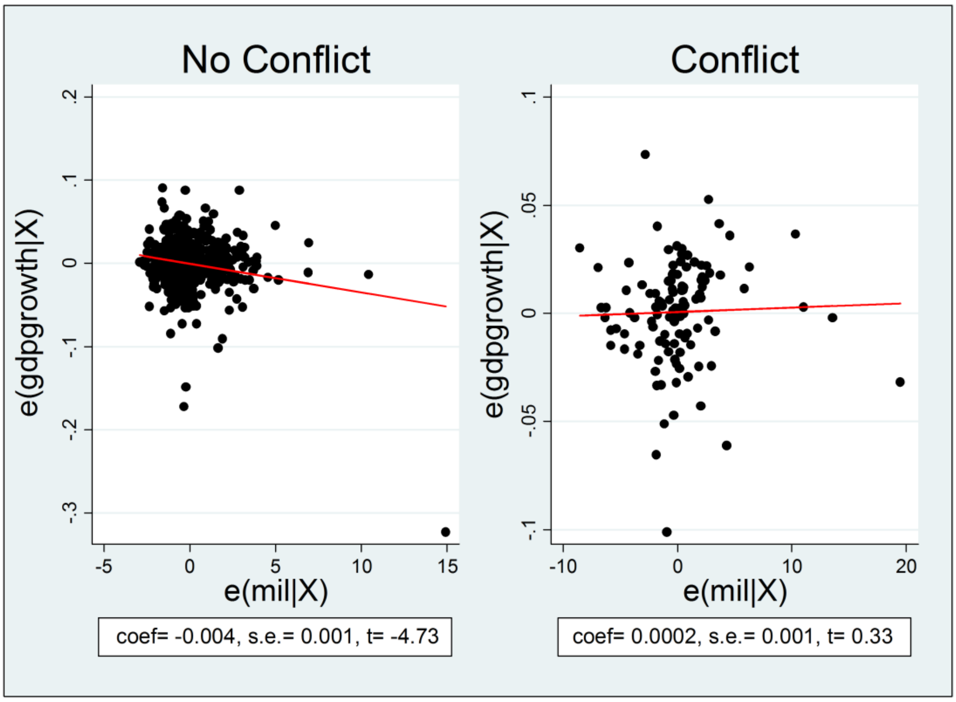
---

[78] The design of initial income interaction with military expenditure is an approach to place countries into income categories (see DeJong and Ripoll, 2006). The evidence of a positive significant interaction term effect between military expenditure and initial income arises by differences in the impact of military expenditure on growth across different income groups.

[79] An analogous analysis as in column 2 of Table 4-11 has been carried by employing military expenditure interaction with external instead of internal threat. The results are qualitatively similar to those reported here. Furthermore, in addition to investigating the internal and external threats separately as potential sources of positive externalities for the non-linear relationship between military spending and growth, the analysis also considered including military spending interactions with both type of threats into the model simultaneously. The results reveal a significant interaction effect of military spending only with internal threats. This is consistent with Kaldor's (1999) argument that the change in the nature of conflicts after the end of Cold-War era led to important changes in the frequency of civil or intra-state wars, illustrating dominance of internal conflicts over external conflicts (see Table 4-1). However this is not to argue that the role of external threats as a source of positive externality for the military spending and growth relationship should be underestimated.

The analysis also suggests a number of paths for future research concerning the effect of military activity on economic growth through natural resource wealth. Various channels by which natural resources can influence the economy have been discussed in the literature. A particularly promising avenue of future research would be to analyze the role of political factors, such as degree of political stability, and the political orientation of the government.

Figure 4-1: Partial Regression Plots for Military Expenditure and Growth



Note: The set of regressors includes log of initial income, log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. The figures are produced using OLS panel regressions.

Table 4-1: Descriptive Statistics for Military Expenditure, Natural Resources and Conflict

Summary Statistics						
Sample split	Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Full sample	Mil. exp.	89	2.789	2.189	0.281	14.964
	Natural res.	89	4.379	6.946	0	38.969
	Ext. Threat	89	1.112	3.009	0	16
	Int. Threat	89	8.382	11.888	0	45
Internal Threat						
No Conflict	Mil. exp.	34	2.479	1.876	0.281	11.247
	Natural res.	34	2.391	3.897	0	13.827
Conflict	Mil. exp.	55	2.980	2.357	0.549	14.964
	Natural res.	55	5.608	8.082	0	38.969
External Threat						
No Conflict	Mil. exp.	63	2.242	1.132	0.281	4.836
	Natural res.	63	4.099	7.206	0	38.969
Conflict	Mil. exp.	26	4.112	3.334	0.933	14.964
	Natural res.	26	5.057	6.355	0	26.112

Note: All descriptive statistics are based on cross sectional averages for the 1970-2010 period. Internal and external threat measures represent cumulative sum of the conflict incidences over the whole sample constructed using UCDP/PRIO data.

Table 4-2
Military Expenditure and Internal Threat
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Internal threat: Onset				Internal Threat Incidence
	Main Model	Outliers Removed	Level of Threat: Low	Level of Threat: High	
	(1)	(2)	(3)	(4)	(5)
Initial GDP p.c. (log)	-0.008**	-0.009**	-0.009**	-0.004	-0.010***
	(0.004)	(0.004)	(0.004)	(0.007)	(0.004)
Mil. exp/GDP	**-0.004***	**-0.006****	**-0.005****	**-0.0002**	**-0.006****
	(0.002)	**(0.003)**	**(0.002)**	**(0.001)**	**(0.003)**
Mil*Threat	**0.130****	**0.205****			**0.0014****
	(0.062)	**(0.097)**			**(0.0006)**
Threat	-0.159	-0.459	0.323	-0.333*	-0.004**
	(0.106)	(0.308)	(0.284)	(0.164)	(0.002)
Pop. growth (log)	-0.009	-0.016	-0.018	-0.017	-0.006
	(0.017)	(0.012)	(0.013)	(0.037)	(0.016)
Life expectancy (log)	0.139***	0.148***	0.148**	0.184***	0.123***
	(0.045)	(0.054)	(0.062)	(0.038)	(0.042)
Investment/GDP	0.152***	0.145***	0.120***	0.072***	0.219***
	(0.034)	(0.037)	(0.041)	(0.017)	(0.049)
Openness (log)	-0.007	-0.011	-0.001	-0.020	-0.020***
	(0.005)	(0.007)	(0.005)	(0.013)	(0.007)
Schooling (log)	-0.011	-0.014	-0.013	-0.015*	-0.007
	(0.008)	(0.009)	(0.012)	(0.008)	(0.008)
Countries/Observations	89/517	82/478	77/419	21/64	85/665
Threshold Analysis					
Internal Threat	0.027	0.032			4.39
	(0.0004)	(0.001)			(3.35)
SPECIFICATION TESTS (*p* -values)					
(a) Hansen Test:	0.990	0.994	0.700	0.872	0.798
(b) Serial Correlation:					
First-order	0.002	0.003	0.007	0.212	0.000
Second-order	0.916	0.745	0.779	0.247	0.190

Note: Columns 1 and 2 estimate military expenditure and economic growth relationship conditional on the probability of internal conflict onset, respectively, with and without outliers. Columns 3 and 4 apply the alternative approach to estimate the impact of military expenditure for countries with high and low internal threat levels. Column 5 employs UCDP/PRIO data to measure for internal threat incidence instead of conflict onset. All specifications control for time fixed effects. The excluded countries in column 2 are Botswana, China, Egypt, Israel, Mali, Korea Rep. and Singapore; in column 3 are Botswana, Israel, Korea Rep., Mali and Singapore; in column 4 are China and Uganda; and in column 5 are Botswana, China, Egypt and Singapore. The outliers are singled out using OLS regressions. The time span for the analysis in columns 1-4 is based on balanced dataset for the 1970-2000 period (T=6), while in column 5 for the 1970-2010 period (T=8). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-3
Military Expenditure and Corruption
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Main Model	**Outliers Removed**	**Level of Corruption**	
			Low	**High**
	(1)	(2)	(3)	(4)
Initial GDP p.c. (log)	-0.011**	-0.008	-0.014*	-0.016**
	(0.004)	(0.005)	(0.008)	(0.007)
Mil. exp/GDP	**-0.018*** **	**-0.017*** **	**0.0002**	**-0.012*** **
	(0.003)	**(0.002)**	**(0.001)**	**(0.003)**
Mil*Corr	**0.004*** **	**0.004*** **		
	(0.001)	**(0.001)**		
Corruption	-0.006**	-0.007**	-0.005**	0.009
	(0.003)	(0.003)	(0.002)	(0.007)
Pop. growth (log)	-0.008	0.001	-0.046**	0.023
	(0.019)	(0.018)	(0.022)	(0.028)
Life expectancy (log)	0.105***	0.099**	0.187*	0.143***
	(0.033)	(0.044)	(0.092)	(0.047)
Investment/GDP	0.260***	0.247***	0.175***	0.355***
	(0.042)	(0.048)	(0.046)	(0.062)
Openness (log)	-0.024***	-0.026***	0.001	-0.043**
	(0.008)	(0.008)	(0.007)	(0.011)
Schooling (log)	-0.003	0.003	0.042**	0.012
	(0.009)	(0.009)	(0.018)	(0.012)
Countries/Observations	82/404	78/384	24/72	72/307
Threshold Analysis				
Corruption (0-6)	4.3 (1.89)	4.5 (2.25)		
SPECIFICATION TESTS (*p* -values)				
(a) Hansen Test:	0.654	0.634	0.792	0.824
(b) Serial Correlation:				
First-order	0.001	0.003	0.032	0.004
Second-order	0.546	0.622	0.389	0.741

Note: The excluded countries in column 2 are Botswana, China, Mozambique and Uganda. Eliminated countries from low corruption level sample are Australia and Finland, while from high corruption level sample are China, Mozambique and Uganda. The estimates reported in columns 3 and 4 are achieved using the "1 lag restriction" technique following Roodman (2009). All specifications control for time fixed effects. The outliers are singled out using OLS regressions. The time span for the analysis is based on balanced dataset for the 1985-2010 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-4
Natural Resources and Civil Conflict Onset
Dependent Variable: Probability of Civil Conflict Onset

	OLS		IV
	(1)	(2)	(3)
Initial GDP p.c. (log)	-0.016***	-0.006***	-0.004**
	(0.005)	(0.001)	(0.002)
Natural Res.	0.061**	0.014*	0.063**
	(0.027)	(0.007)	(0.028)
Control Set	Yes	Yes	Yes
Observations	517	506	494
R-squared	0.243	0.343	
Joint exogeneity p			0.044
Instrument overid p			0.892
Exc. inst. F- Initial GDP p.c.			31.07
Exc. inst. F- Nat. Res.			12.53

First Stage Results for Instruments

	(1) Initial GDP p.c. (log)	(2) Natural Res.
Dist. to major river	-0.049***	-0.004*
	(0.018)	(0.002)
Soil	-0.621***	-0.100***
	(0.142)	(0.016)
Tropical	-0.428***	0.019**
	(0.074)	(0.009)
Democracy, lagged	0.046***	-0.002*
	(0.008)	(0.001)

Note: Columns 1 and 2 estimates economic growth specification, respectively, with and without outliers. Column 3 applies instrumental variables approach using the specification as in column 2. In addition to variables of interest reported in the upper panel, all specifications control for military expenditure ratio, log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. The excluded countries are China and Israel. The outliers are singled out using OLS regressions. ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-5
Military Expenditure and Natural Resources
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Main Model (1)	**Outliers Removed** (2)	**Alternative Model** (3)
Initial GDP p.c. (log)	-0.013***	-0.011**	-0.014**
	(0.004)	(0.005)	(0.007)
Mil. exp/GDP	**-0.020*** **	**-0.019*** **	**-0.011** **
	(0.003)	**(0.003)**	**(0.005)**
Natural Res.	-0.017	-0.019	
	(0.031)	(0.034)	
Mil*Nat	**0.025** **	**0.027** **	
	(0.012)	**(0.013)**	
Natural Res$_{highcorr}$			0.014
			(0.066)
Natural Res$_{lowcorr}$			-0.531**
			(0.222)
Mil*Nat$_{highcorr}$			0.016
			(0.031)
Mil*Nat$_{lowcorr}$			**0.269** **
			(0.133)
Corruption	-0.004	-0.005*	
	(0.003)	(0.003)	
Mil*Corr	**0.004*** **	**0.004*** **	
	(0.001)	**(0.001)**	
Pop. growth (log)	-0.015	-0.006	0.028
	(0.017)	(0.017)	(0.027)
Life expectancy (log)	0.112***	0.112**	0.159***
	(0.030)	(0.042)	(0.053)
Investment/GDP	0.233***	0.225***	0.316***
	(0.042)	(0.047)	(0.062)
Openness (log)	-0.021***	-0.023***	-0.031***
	(0.008)	(0.008)	(0.009)
Schooling (log)	-0.004	0.001	0.015
	(0.008)	(0.009)	(0.014)
Countries/Observations	82/404	78/384	79/389
SPECIFICATION TESTS (*p* -values)			
(a) Hansen Test:	0.978	0.986	0.820
(b) Serial Correlation:			
First-order	0.001	0.004	0.002
Second-order	0.361	0.461	0.985

Note: Columns 1 and 2 report the estimation results, respectively, with and without outliers under the first estimation approach. Column 3 employs the second estimation approach using the "1 lag restriction" technique following Roodman (2009) and removing outliers. All specifications control for time fixed effects. Eliminated countries in column 2 are Botswana, China, Mozambique and Uganda; in column 3 are China, Mozambique and Uganda. The outliers are singled out using OLS regressions. The time span for the analysis is based on balanced dataset for the 1985-2010 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-6
Excluding Low Natural Resource Share Countries
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Above 1st Decile Share		**Above 1st Quartile Share**		**Above Median Share**	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (log)	-0.012**	-0.014**	-0.007*	-0.012*	-0.011**	-0.009
	(0.005)	(0.007)	(0.004)	(0.007)	(0.004)	(0.006)
Mil. exp/GDP	**-0.020*** **	**-0.008**	**-0.021*** **	**-0.008***	**-0.019*** **	**-0.011*** **
	(0.003)	**(0.005)**	**(0.003)**	**(0.005)**	**(0.002)**	**(0.005)**
		[0.102]				
Natural Res.	-0.019		-0.050		-0.027	
	(0.040)		(0.032)		(0.027)	
Mil*Nat	**0.029***		**0.031*** **		**0.018**	
	(0.016)		**(0.012)**		**(0.011)**	
					[0.112]	
Natural $Res_{highcorr}$		0.028		0.026		-0.032
		(0.065)		(0.064)		(0.068)
Natural $Res_{lowcorr}$		-0.501**		-0.561**		-0.777**
		(0.208)		(0.222)		(0.292)
Mil*$Nat_{highcorr}$		0.004		0.001		0.021
		(0.033)		(0.033)		(0.029)
Mil*$Nat_{lowcorr}$		**0.295*** **		**0.319*** **		**0.409*** **
		(0.132)		**(0.140)**		**(0.167)**
Corruption	-0.003		-0.006*		-0.005	
	(0.003)		(0.003)		(0.004)	
Mil*Corr	**0.004*** **		**0.005*** **		**0.005*** **	
	(0.001)		**(0.001)**		**(0.001)**	
Control Set	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	74/364	74/364	64/314	64/314	43/210	43/210
SPECIFICATION TESTS (*p* -values)						
(a) Hansen Test:	0.846	0.903	0.880	0.984	0.944	0.398
(b) Serial Correlation:						
First-order	0.004	0.002	0.003	0.002	0.003	0.002
Second-order	0.416	0.630	0.515	0.711	0.938	0.570

Note: Columns 1 and 2 exclude the countries below the 1st decile of natural resource rents as a share of GDP (8 countries); columns 3 and 4 exclude countries below the 1st quartile (18 countries); and columns 5 and 6 exclude countries below the median (39 countries). All specifications employ log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The time span for the analysis is based on balanced dataset for the 1985-2010 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses; estimates in square brackets are p-values.

Table 4-7
Excluding Big Producers
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	Average Nat. resource Share	Average Mil. Exp. Share	Average Growth Rate	Coeff.	S. E.	p value
			Remove OPEC Countries			
Algeria	19.51	2.57	1.28			
Ecuador	13.83	2.19	1.77		**Mil*Nat**	
Indonesia	10.31	2.34	4.19	0.026	0.011	0.024
Iran	26.11	4.69	0.89		**Mil*Nat**$_{lowcorr}$	
Venezuela	26.15	1.75	0.50	0.230	0.116	0.051
			Remove Big Oil and Gas Producers			
Brazil	2.02	1.52	2.29			
Canada	3.78	1.78	1.88		**Mil*Nat**	
China	7.34	1.73	6.90	0.022	0.011	0.046
Iran	26.11	4.69	0.89		**Mil*Nat**$_{lowcorr}$	
Mexico	6.89	0.55	1.93	0.205	0.103	0.051
United States	1.64	5.37	1.68			
Venezuela	26.15	1.75	0.50			
			Remove Big Minerals and Coal Producers			
Australia	3.87	2.49	2.28			
Bolivia	10.73	2.36	0.44			
Botswana	1.78	3.32	5.75		**Mil*Nat**	
Chile	9.85	4.16	2.29	0.022	0.012	0.064
Jamaica	5.58	0.82	0.66		**Mil*Nat**$_{lowcorr}$	
Jordan	0.67	11.25	-0.02	0.267	0.121	0.030
Morocco	1.49	4.11	2.38			
Peru	6.41	3.05	1.28			
Zambia	13.51	2.73	-0.27			
			Remove All Subsets			
Algeria	19.51	2.57	1.28			
Australia	3.87	2.49	2.28			
Bolivia	10.73	2.36	0.44			
Botswana	1.78	3.32	5.75			
Brazil	2.02	1.52	2.29			
Canada	3.78	1.78	1.88			
Chile	9.85	4.16	2.29			
China	7.34	1.73	6.90		**Mil*Nat**	
Ecuador	13.83	2.19	1.77	0.021	0.009	0.037
Indonesia	10.31	2.34	4.19		**Mil*Nat**$_{lowcorr}$	
Iran	26.11	4.69	0.89	0.193	0.114	0.094
Jamaica	5.58	0.82	0.66			
Mexico	6.89	0.55	1.93			
Morocco	1.49	4.11	2.38			
Peru	6.41	3.05	1.28			
United States	1.64	5.37	1.68			
Venezuela	26.15	1.75	0.50			
Zambia	13.51	2.73	-0.27			

Note: The estimates are achieved according to specifications under the first and the second estimation approach as in Table 4-5. Big commodity producers reflect countries with more than 3% of total world supply which belong to the list of top 10 biggest producers in the world by commodity. Data for commodities produced in a country are obtained from the following sources: minerals from British Geological Survey 2000-2008; Oil, natural gas and coal from US Energy Information Administration 1980-2009. The number of countries/observations for each panel is, respectively, 77/379, 75/369, 73/359 and 63/309. The time span for the analysis is based on balanced dataset for the 1985-2010 period (T=5).

Table 4-8
Exclusion of Countries with Unusual Characteristics
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	Average Nat. resource Share	Average Mil. Exp. Share	Average Growth Rate	Coeff.	S. E.	p value
Remove Countries with High Internal Threat Levels and High Natural Resource Shares						
Algeria	19.51	2.57	1.28			
Colombia	4.97	2.31	2.39		**Mil*Nat**	
Congo Dem. Rep.	7.37	2.24	-3.59	0.026	0.012	0.039
Indonesia	10.31	2.34	4.19		**Mil*Nat$_{lowcorr}$**	
Iran	26.11	4.69	0.89	0.218	0.102	0.035
Peru	6.41	3.05	1.28			
Sudan	4.30	3.00	0.99			
Remove Countries with High External Threat Levels and High Natural Resource Shares						
China	7.34	1.73	6.90		**Mil*Nat**	
				0.022	0.014	0.106
Egypt	12.64	8.66	3.04		**Mil*Nat$_{lowcorr}$**	
				0.217	0.107	0.046
Iran	26.11	4.69	0.89			
Remove All Subsets						
Algeria	19.51	2.57	1.28			
China	7.34	1.73	6.90			
Colombia	4.97	2.31	2.39			
Congo Dem. Rep.	7.37	2.24	-3.59		**Mil*Nat**	
Egypt	12.64	8.66	3.04	0.022	0.015	0.138
Indonesia	10.31	2.34	4.19		**Mil*Nat$_{lowcorr}$**	
Iran	26.11	4.69	0.89	0.217	0.103	0.039
Peru	6.41	3.05	1.28			
Sudan	4.30	3.00	0.99			

Note: The estimates are achieved according to specifications under the first and the second estimation approach as in Table 4-5. Countries with high internal threat levels and high natural resource shares are specified as those experienced internal threat above the mean of cumulative internal conflict incidence with natural resource levels above the mean. Countries with high external threat levels and high natural resource shares are specified as those experienced external threat more than 1 standard deviation from the mean of cumulative external conflict incidence with natural resource levels above the mean. The number of countries/observations for each panel is, respectively, 75/370, 79/389 and 73/360. The time span for the analysis is based on balanced dataset for the 1985-2010 period (T=5).

Table 4-9
Typologies of Commodities
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Energy Resources		**Oil Resources**	
	(1)	(2)	(3)	(4)
Initial GDP p.c. (log)	-0.016**	-0.013**	-0.007	-0.009
	(0.006)	(0.006)	(0.007)	(0.006)
Mil. exp/GDP	**-0.020*** **	**-0.010** **	**-0.009***	**-0.002**
	(0.002)	**(0.005)**	**(0.005)**	**(0.003)**
Energy res.	-0.073			
	(0.050)			
Oil res.			-0.050	
			(0.056)	
Mil*Energy	**0.051*** **			
	(0.017)			
Mil*Oil			**0.041** **	
			(0.019)	
$Energy_{highcorr}$		-0.145		
		(0.092)		
$Energy_{lowcorr}$		-0.714***		
		(0.262)		
$Oil_{highcorr}$				-0.043
				(0.066)
$Oil_{lowcorr}$				-0.540**
				(0.225)
Mil* $Energy_{highcorr}$		0.068**		
		(0.030)		
Mil* $Energy_{lowcorr}$		**0.404** **		
		(0.157)		
Mil* $Oil_{highcorr}$				0.036
				(0.025)
Mil* $Oil_{lowcorr}$				**0.279** **
				(0.121)
Corruption	-0.002		-0.003	
	(0.004)		(0.004)	
Mil*Corr	**0.004*** **		**0.002***	
	(0.001)		**(0.001)**	
Control Set	Yes	Yes	Yes	Yes
Countries/Observations	82/404	82/404	74/365	74/365
SPECIFICATION TESTS (*p* -values)				
(a) Hansen Test:	0.745	0.699	0.976	0.954
(b) Serial Correlation:				
First-order	0.003	0.003	0.000	0.000
Second-order	0.530	0.583	0.403	0.456

Note: All specifications employ log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The estimates are achieved using the "1 lag restriction" technique following Roodman (2009). The time span for the analysis is based on balanced dataset for the 1985-2010 period (T=5). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-10
Different Time Windows
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	1985-2000 (1)	1985-2005 (2)	1990-2010 (3)	1995-2010 (4)
Initial GDP p.c. (log)	-0.012	-0.009**	-0.013***	-0.013***
	(0.008)	(0.004)	(0.004)	(0.005)
Mil. exp/GDP	**-0.024*** **	**-0.022*** **	**-0.020*** **	**-0.020*** **
	(0.003)	**(0.003)**	**(0.003)**	**(0.003)**
Natural Res.	-0.209*	-0.102**	-0.017	-0.013
	(0.124)	(0.048)	(0.031)	(0.034)
Mil*Nat	**0.067** **	**0.047*** **	**0.025** **	**0.025* **
	(0.030)	**(0.014)**	**(0.012)**	**(0.015)**
Corruption	-0.008**	-0.006**	-0.004	-0.003
	(0.004)	(0.003)	(0.003)	(0.003)
Mil*Corr	**0.005*** **	**0.005*** **	**0.004*** **	**0.004*** **
	(0.001)	**(0.001)**	**(0.001)**	**(0.001)**
Control Set	Yes	Yes	Yes	Yes
Countries/Observations	82/240	82/322	82/404	82/322
SPECIFICATION TESTS (*p* -values)				
(a) Hansen Test:	0.181	0.997	0.978	0.967
(b) Serial Correlation:				
First-order	0.009	0.000	0.002	0.002
Second-order	N/A	0.961	0.371	0.400

Note: All specifications employ log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The time series dimension (T) for columns 1- 4 is, respectively, 3, 4, 4 and 3. ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-11
Allowance for Other Non-linearities
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	(1)	(2)
Initial GDP p.c. (log)	-0.011**	-0.015*
	(0.005)	(0.008)
Mil. exp/GDP	**-0.037*** **	**-0.052*** **
	(0.008)	**(0.011)**
Natural Res.	-0.015	-0.151*
	(0.035)	(0.090)
Mil*Nat	**0.028** **	**0.066*** **
	(0.014)	**(0.022)**
Corruption	-0.003	-0.004
	(0.003)	(0.005)
Mil*Corr	**0.002*** **	**0.003** **
	(0.001)	**(0.001)**
Mil*GDP	**0.003** **	**0.004** **
	(0.001)	**(0.002)**
Threat		-1.276***
		(0.399)
Mil*Threat		**0.439*** **
		(0.119)
Control Set	Yes	Yes
Countries/Observations	78/384	78/222
SPECIFICATION TESTS (*p* -values)		
(a) Hansen Test:	0.985	0.587
(b) Serial Correlation:		
First-order	0.003	0.005
Second-order	0.709	N/A

Note: Both columns are estimated removing outlier countries. Eliminated countries in column 1 are Botswana, China, Mozambique and Uganda; in column 2 are Botswana, China, Mozambique and Sudan. Column 2 employs probability of civil war onset as threat measure. All specifications employ log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects as an additional control set. The outliers are singled out using OLS regressions. The time span for the analysis in column 1 is based on balanced dataset for the 1985-2010 period (T=5), while in column 2 for the 1985-2000 period (T=3). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in the parentheses.

5. Commodity Price Shocks, Conflict and Growth: The Role of Institutional Quality and Political Violence

5.1. Introduction

The effect of resource abundance on growth prospects is a perennially important topic in the growth and development literature. How do resource windfalls affect a country's development level? And how do additional revenues generated by resource abundance influence economic growth? These are important questions, as the effects of income shocks generated by resource windfalls cannot be referred to as generic income changes. Because resource booms typically translate into direct windfalls into the hands of political elite, these shocks may have very different political and economic consequences than other sources of income shocks (Sachs and Warner, 2001; Caselli and Tesei, 2011). Considered alternatively, resource windfalls may just represent short run gains to an economy which do not feed into future development.

This analysis empirically investigates the relationships between resource windfalls, political regimes, conflict and growth using a distinctive commodity price shock measurement. The investigation clarifies the potential mechanism behind the ambiguous outcomes of the existing resource literature, particularly showing that resource windfalls have significant effects on conflict only in politically unstable autocracies, where these effects are heterogeneous in the response, conditional on a country's initial political violence level. Specifically, a positive shock to an autocratic country's flow of resource rents decreases conflict potential if within-country political violence level is high, while for autocracies with relatively low political violence levels the opposite effect occurs. The investigation also contributes to the growth literature by showing that resource shocks are positively associated with growth in democracies and in politically stable autocracies, while undermining a country's economic performance for politically unstable autocracies.

In order to motivate the empirical analysis and facilitate the interpretation of the results, the paper opens the discussion with a following novel story as developed in Caselli and Tesei (2011), Besley and Persson (2011). Assuming that the governing elite or ruler has complete control of the flow of income from natural resources, the growth prospects of a country will depend on decisions of the government regarding how to diversify this revenue. Countries where the ruler decides to invest into the well-managed development activities are likely to enjoy a stable socio-political environment and experience higher economic growth from resource windfalls. However if the ruler chooses to invest this revenue into rent-seeking activities or to direct them into unproductive sectors, this will enhance the likelihood of economic and political instability and lead to diminished growth. Investing resource revenues into "self-preservation" activities in order to safeguard its political survival as a ruler is also likely to further undermine economic performance since these resources could have been invested into development activities, and hence can be referred as a wasted amount of investment out of productive into unproductive sector.

Self-preservation activities can range from the mild (e.g., direct and indirect vote-buying, imprisoning) to the extreme case scenarios (e.g., violent repression, execution), which will also shape the decision of opposition groups of whether or not to challenge the incumbent government conditional on the threat level faced. For instance, in the context of potential conflict scenarios (where both an incumbent government and an opposition group can each make an investment into violence), an increase in resource windfalls, on one hand, may serve as an incentive for rebellions promoting rapacity over these resources, and hence increase violence by raising the gains from appropriation if they are successful ("state prize" theories); on the other hand, it may also serve for the effectiveness of the state to confront the rebellions and decrease the likelihood for insurgents of being successful ("opportunity cost" arguments), where investment into self-preservation activities by an incumbent government is expected to further decrease the incentives of opposition group to resist against the government if the threat level is sufficiently large enough. It is also worth mentioning that these outcomes are expected to be the case *only* for countries with an unstable political environment and non-cohesive institutions.

Considering instead how these effects are reflected in economic growth provides another source of ambiguity. For instance, investments in self-preservation activities are expected to decrease the possibility of conflict and hence promote growth by delivering peace dividends; however, it also refers to the amount of investment that could be directed into delivering public goods through well-managed development projects, thus leading to reduced growth. Clearly, these determinants – resource windfalls, political institutions and violence, all interact to influence each other; and the relative dominance and sign of these effects in cross country analysis, as well as how these effects are transferred onto growth, can only be ascertained by empirical investigation.

Moreover, the main determinant for the decision-making processes here is the amount of revenue accruing from resource windfalls, which is partly determined by the payoff from staying in the office, as political survival as a ruler implies that the current elite remains in control of future revenues; and partly explained by budget constraints, since at low levels of resource income the incentive to engage in self-preservation activities (or oppose the incumbent government) is relatively low, as the future "pie" to hold on to is small. At higher levels instead the future benefits from holding on to power are sufficiently large; and the larger is the "pie", there is more likelihood that the ruler finds it optimal to spend on self-preservation.

The remainder of the paper is organized as follows. The next section reviews the long-lasting debate in the literature regarding the impact of resource abundance on institutional quality, conflict and growth. The methodology and data employed is described in Section 5.2. Section 5.3 presents the estimation results and Section 5.4 concludes.

5.1.1. Related Literature

Many researchers have noted the resource-led development failures – economic and political factors that may have played a role in the disappointing performance of resource-intensive economies in the 1970s and 1980s (Gelb, 1988; Auty, 1990), although the adverse effects of resource abundance on growth was first confirmed in the 1990s by Sachs and Warner (1995), igniting a subsequent tranche of research that focuses on the resource curse paradox. The literature has distinguished between no fewer than three different dimensions of the resource curse effect, where resources are associated with (i) slower economic growth, (ii) undemocratic regime types, and (iii) violent civil conflict.

Among the popular early explanations for the curse effect on growth are rent-seeking analyses (e.g., Torvik, 2002) where for grabber friendly countries rent-seeking and production are competing activities. By shifting away from productive activities, the government allocates more of its revenue to inefficient public sector activities leading aggregate investment levels to fall, while public and private consumption to increase. Lowering investment levels may also lead to a lower quality of investment projects (e.g., white elephants). Stories based on "Dutch-disease" arguments are other explanations for the curse effect where the non-resource sector is the long-run engine of growth due to increasing returns at the sector level, but becomes crowded out by the resource sector (Sachs and Warner, 1999). Empirical support for these views is provided by various authors, including Ross (1999, 2001), Leite and Weidmann (2002), Sala-i-Martin and Subramanian (2003), Isham *et al.* (2005), and Bulte *et al.* (2005). Mehlum *et al.* (2006) demonstrate that the impact of resource abundance is conditional on institutional quality, i.e. while countries with good institutions which promote accountability and state competence will tend to benefit from resource abundance, countries without such institutions may suffer from a resource curse (see also Jensen and Wantchekon, 2004; Robinson *et al*., 2006). Along with these transmission channels, another feature that has emerged in the resource curse literature is the link between resources and conflict pioneered by empirical contribution in Collier and Hoeffler (1998).[80]

However the validity of these results has been criticized by Brunnschweiler and Bulte (2008, 2009) drawing attention in the literature. The authors disputed the arguments that abundant resources lead to bad institutions, higher conflict potential or slower growth by emphasizing their concerns regarding the endogeneity of resource exports ratio to GDP where the denominator explicitly measures the magnitude of other activities in the economy, i.e. the ratio is not independent of

[80] Although the resource-conflict link is increasingly viewed as a stylized fact in economics and political science (see e.g., Ross 2004a), the explanations of this evidence are mixed. Focussing on the economic roots of conflict, Fearon (2005), Ross (2006), De Soysa and Neumayer (2007), and Lujala (2009) highlight the role of (legal) oil and mineral resource trading. The probability of foreign intervention (Rosser, 2006) and the probability of suffering from economic shocks (Collier and Hoeffler, 2005) are other explanations as to why resources might be linked to conflict. Other explanations of the resource-conflict link arise around political (state-strength) perspectives of (potential) rebels as key decision-makers (e.g., Dunning, 2005; Humpreys, 2005). Ballantine (2003) has emphasized that the mix of greed and grievance can be particularly effective and relevant as an explanation of the onset of war. These are not to argue that there were no "dissident" views: e.g., Homer-Dixon (1999) who suggests resource scarcity, rather than abundance as a driver of violent conflict.

economic policies and institutions which is to the large extent produced by choices of individual governments.[81]

In the light of endogeneity concerns regarding the resource rent share, measuring resource shocks with changes in international commodity prices is more promising since they are typically unaffected by the behaviour of individual countries (Deaton and Miller, 1995).[82] Alternatively viewed, since world commodity prices are set in international markets, they are less likely to be influenced by the socio-economic and political events in a single country. While empirical studies by Deaton and Miller (1995) and Raddatz (2007) do find that commodity price shocks raise growth, Collier and Goderis (2009) demonstrate that this positive association is only the case in the short run; and a positive shock to commodity prices can lead to slower growth in the long run conditional on poor governance.

A recent literature has also investigated the effect of commodity price shocks on political regime types as a proxy for institutional quality.[83] Using commodity price changes as instruments for income changes, Burke and Leigh (2010) find insignificant effects of commodity-driven income changes on political regimes. Bruckner *et al*. (2012) instead find a positive effect of oil-price shocks interacted with the share of net oil exports in GDP for movements towards democracy. A good summary of this literature (with associated weaknesses and advantages regarding the approaches employed) is provided in Caselli and Tesei (2011) where the findings

[81] Alternative measures of resource abundance have been also used in the literature, casting some doubts on the consistency and robustness of the curse. For example, Brunnschweiler (2008) finds no curse evidence using World Bank resource data; Alexeev and Conrad (2009) employ several measures of resource abundance, including hydrocarbon deposits per capita, and oil and mining outputs, and find no negative effects on income. Lederman and Maloney (2007) also demonstrate that the resource curse effect disappears when employing system GMM.

[82] During the analysis, the issue of large producers with potential to influence world prices is addressed, with findings that the results are robust and not altered by these economies.

[83] For the relationship between political regimes and income shocks measured other than commodity price changes, see e.g., Acemoglu and Robinson (2001), Acemoglu *et al*. (2008) who empirically investigated the causal relationship between income and democracy; Haber and Menaldo (2011) who concentrated on windfalls from natural resources, finding no effect of oil windfalls on greater autocracy. As for the literature studying the effects of resource windfalls on political institutions (and institutional quality more broadly) other than democracy/autocracy, see also the theoretical studies of Baland and Francois (2000), and Torvik (2002), all whom study theoretically the consequences of windfalls for rent seeking, and Leite and Weidman (2002) and Salai-i-Martin and Subramanian (2003) that present corresponding empirical evidence (where rent-seeking is usually measured through proxies of corruption).

demonstrate that while commodity price shocks have no effect on political system in democracies, a positive shock to an autocratic country's flow of resource rents significantly exacerbates the autocratic nature of the political system which itself is heterogeneous in the response across deeply and moderately entrenched autocratic regimes.

There is also an emerging literature regarding the link between conflict and commodity prices, yet the results are ambiguous. While Bruckner and Ciccone (2010) and Savun and Cook (2011) demonstrate that negative shocks to export prices increase the risk of civil conflict, Besley and Persson (2008) demonstrate that higher world market prices of exported, as well as imported, commodities are strong and significant predictors of higher within-country incidence of civil conflict.[84] Differentiating the effect of labour intensive commodities and natural resources on conflict within Colombia, Dube and Vargas (2013) show that a rise in international prices of oil, coal and gold increases violence, while this association is negative when commodities like coffee, sugar, bananas and tobacco are considered (see also Angrist and Kugler, 2008).[85]

Although it seems that the case studies of individual countries offer relatively clear-cut evidence, the relationship between resource windfalls and conflict for cross-country analysis is not clear. Along with these complications, Bazzi and Blattman (2011) suggest "absence of evidence" from resource windfalls on conflict.

5.2.1. Empirical Methodology

The investigation firstly explores the link between resource windfalls and conflict following a similar specification to Bruckner and Ciccone (2010), where the indicator for civil conflict onset linearly responds to the changes in commodity price index. Starting from this benchmark, the analysis further investigates the impact of

[84] See also Besley and Persson (2010), who demonstrate that resource dependence can increase the propensity towards conflict while lowering income and state capacity; and Besley and Persson (2011), who show that natural disasters are negatively correlated with income per capita and induce greater political violence.

[85] The theoretical foundation of these perspectives may be traced back to Dal Bo and Dal Bo (2011).

changes in commodity prices on conflict possibility, conditional on political institutions and a country's political violence level.[86]

The analysis then turns to the exploration of how these relationships between resource windfalls, political regimes and violence are reflected in economic growth. The baseline investigation for the growth analysis employs similar specification used by Collier and Goderis (2009). Letting the subscripts *i* and *t* represent country and time period respectively, the estimated model can be written as

$$y_{it} - y_{i(t-1)} = \alpha\, y_{i(t-1)} + \theta_1 Comprice growth_{i(t-1)} + \varphi' X_{i(t-1)} + \beta' Z_{i(t-1)} + \mu_t + \xi_i + \varepsilon_{it} \quad (5i)$$

where y is log of real per capita income, $Comprice growth_{i(t-1)}$ is the change in commodity price index where the variation across countries is generated by applying country-commodity specific weights based on net export baskets of individual countries (see the Section 5.2.2), $X_{i(t-1)}$ is the vector of interaction variables (political regimes and political violence) with price index, $Z_{i(t-1)}$ is a vector of additional control variables, μ_t is a period-specific constant, ξ_i is an unobserved country-specific effect, and ε_{it} is an error term.

The hypothesis for these relationships is that the impact of resource windfalls on both conflict onset and economic growth is a non-linear function of a country's political institutions and political violence levels, where the marginal impact of price shocks is increasing while within-country political violence (stability) level decreases (increases). Alternatively, governments in countries with stable socio-political environments have a greater incentive to spend the resource windfalls beneficially, whereas in politically unstable countries with non-cohesive institutions the resource windfalls may be spent in unproductive directions.

The analysis for growth estimation employs the System GMM dynamic panel estimator by Arellano and Bover (1995) and Blundell and Bond (1998), which builds

86 In order to keep the specification straightforward and to concentrate on how the conflict possibility responds non-linearly to the changes in commodity price index conditional on political institutions and within-country political violence level, the investigation does not include the additional two lags of price index into the specification as is done in Bruckner and Ciccone (2010). In addition, it is also worth mentioning that both lags demonstrated no impact on conflict onset when are included; thus a parsimonious specification without additional lags during the analysis was preferred.

on the GMM Difference estimator developed by Arellano and Bond (1991).[87] This approach has the advantage of addressing the issues of joint endogeneity of all explanatory variables in a dynamic formulation, and of potential biases induced by country specific effects.[88] Moreover, to ensure that the estimated effect is not driven by the number of instruments, the analysis employs either collapsing instruments approach or the "1 lag restriction" technique introduced by Roodman (2009) that uses only certain lags instead of all available lags as instruments. The treatment of each regressor according to their exogeneity levels is based on upper and lower bound conditions (Roodman, 2006).[89]

Along with coefficient estimates obtained using System GMM estimator, the tables also report three tests of the validity of identifying assumptions they entail: Hansen's (1982) test of over-identifying restrictions for the joint validity of the moment conditions; and Arellano and Bond's (1991) AR(1) and AR(2) tests in first differences. AR (1) test is of the null hypothesis of no first-order serial correlation, which can be rejected under the identifying assumption that error term is not serially correlated; and AR (2) test is of the null hypothesis of no second-order serial correlation, which should not be rejected. In addition, to deal with heteroskedasticity, the Windmeijer (2005) small-sample correction is applied.

[87] Since the dependent variable for the investigation of the relationship between resource windfalls and conflict onset is dichotomous, the analysis employs largely preferred in the literature the ordinary least squares (OLS) estimator. In addition, the investigation also considered Logit and Probit models, which indicated that the results are robust and not altered by the choice of estimator. The results from employing these additional estimators are available upon request.

[88] It is of note that GMM estimators are designed for situations with "small T and large N" panels, implying few time periods and many individuals; and employing System GMM with annual data for 1963-2010 period might raise question whether the System GMM is the appropriate estimating approach. Alternatively viewed, using long T dimension can lead to overfitting endogenous variables and hence weaken the Hansen test putting the reliability of over-identifying restrictions test under question. Indeed, some of the Hansen test statistics during the analysis yield extremely high p-values (e.g. in excess of 0.90) and therefore, the results from these specifications should be read with caution since this can be a warning signal that too many moment restrictions are in use. However, it is of emphasis that the analysis checked whether the estimated results for growth relationship are driven by the choice of estimator by running the same exercises employing OLS estimator as a comparison which indicated that the results are in line with those achieved using System GMM estimator. These results are available upon request.

[89] For detailed information regarding upper and lower bound conditions, see Appendix 2-A.

5.2.2. Data and Descriptive Statistics

The initial analysis is based on an unbalanced dynamic panel dataset consisting of 135 countries over the 1963-2010 period.[90] The dependent variable, logged per capita real (Laspeyres) GDP growth, is constructed using data from the Penn World Table (PWT 7.1). The log of initial income per capita is used as regressor.

The measure of resource wealth is the commodity export price index which is constructed using a similar methodology to Deaton and Miller (1995), Dehn (2000) and Collier and Goderis (2009). More specifically, first, data on world commodity price indices and commodity export and import values are collected for as many commodities as data availability allowed. All commodity price indices are extracted from the IMF International Financial Statistics (IFS) dataset, where the list of 54 commodities used to construct the composite index is listed in Appendix Table 5-D3. Export and import data by commodity, country and year are collected from the United Nation's Comtrade data set, which reports dollar values of exports and imports according to the SITC1 system, for the period 1963 to 2010. To construct the composite commodity export price index, total net export value (exports minus imports) of all commodities in 1990 for which the country is a net exporter is first calculated for each country. Then the individual 1990 net export values for each commodity are divided by this total in order to achieve 1990 country-commodity specific weights, w_i, which are held fixed over time and applied to the world price indices of the same commodities to form the country-specific geometrically weighted index of commodity export prices. More specifically, for each year and country the geometrically weighted index is constructed as follows:

$$P = \prod_i p_i^{w_i}$$

where w_i is 1990 country-commodity specific weight and p_i is the international commodity price index for the commodity i. The weighting item, w_i, can be interpreted as a value of commodity i in total value of all commodities, n, for constant base year j:

$$w_i = \frac{P_{ji}Q_{ji}}{\sum_n P_{jn}Q_{jn}}$$

[90] See Appendix Tables 5-D1 and 5-D2 for the list of countries and descriptive statistics.

Finally, to allow the effect of commodity export prices to be larger for countries with higher commodity exports, the log of geometrically weighted index of commodity export prices for each country i and year t, P_{it}, is weighted by the 1990 share of net commodity exports in a country's GDP, denoted s_i, resulting in the final shape of the composite commodity price index, ${P_{it}}^{s_i}$. This contrasts to Collier and Goderis (2009) (see also Bazzi and Blattman, 2011), where the final construction is instead realized by multiplying the weighted index with export shares which might cause potential endogeneity issues as discussed in Brunnschweiler and Bulte (2008). The separate indices for different type of commodities are constructed in a similar way.[91]

Although the measurement of commodity price shocks using shares of commodities in a given year is far from ideal, it has several advantages. Since the index uses a constant base year, it does not cope well with shifts in the structure of trade. In particular, the index does not capture resource discoveries and other quantity shocks after the base year. Nor does it capture temporary volume shocks other than those which happen to occur in the base year itself. However, since the purpose is to capture price shocks rather than quantity movements, but at the same time differentiate between resource abundant and resource scarce countries, it is desirable to hold volumes constant. This also avoids possible endogeneity problems arising in the event of a volume response to price changes. Nevertheless, the index will understate income effects of a given price change. In addition, as discussed above, the geometrical weighting scheme has the comparative advantage in avoiding the potential endogeneity issues that can be faced with when using arithmetically weighted indices.[92]

As a proxy for institutional quality outcome, the analysis employs the variable of *polity2* in the Polity IV database (Marshall and Jaggers, 2010), which is widely used

[91] See also Appendix 5-C for more detailed information regarding the sources and the data coverage methodology used to construct the price index.

[92] Caselli and Tesei (2011) suggested a nice strategy of using a country's principal export commodity prices to capture the effect of price shocks. However, the analysis here did not follow this strategy since only a few oil producing countries are specialised to the point of exporting only a single commodity, so for the majority of countries the full ramifications of being a commodity exporter cannot be determined with reference to just a single commodity price series. In addition, given the findings from the literature that different type of commodities are likely to behave very differently within a given country (see e.g., Dube and Vargas, 2013), conditional on everything else being constant, the broad aggregate indices of commodity prices based on export baskets of individual country was preferred.

in the empirical political-science literature (e.g., Acemoglu *et al.*, 2008) to measure the position of a country on a continuum of autocracy-democracy spectrum. It aggregates information on several building blocks, including political participation (existence of institutions through which citizens can express preferences over policies and leaders), constraints on the executive, and guarantees of civil liberties both in daily life and in political participation, as evaluated by Polity IV coders. *Polity2* varies continuously from -10 (extreme autocracy) to +10 (perfect democracy). The analysis follows the convention in the vast majority of the literature that interprets negative values of *polity2* as pertaining to autocracies and positive ones to democracies (e.g., Persson and Tabellini, 2006, 2009).

Data on civil conflict is obtained from UCDP/PRIO Armed Conflicts 2012 Dataset of the International Peace Research Institute's (PRIO) Centre for the Study of Civil War and the Uppsala Conflict Data Programme (UCDP). The UCDP/PRIO Armed Conflict Database defines civil conflict as a "contested incompatibility which concern government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle deaths". Civil conflict outbreak is captured by defining civil conflict onset indicator that is unity if there is conflict in year *t* but not in *t-1*, and zero if there is no civil conflict in *t* and *t-1*; if there is a conflict in *t-1*, the year *t* civil conflict onset indicator is not defined.

To measure the political violence in the country and its actual or potential impact on governance, the analysis employs the index of internal conflict risk – *proxy for stability* – obtained from International Country Risk Guide (ICRG) Dataset.[93] The index ranges from 0 to 12, where the highest rating is given to those countries where there is no armed or civil opposition to the government and the government does not indulge in arbitrary violence, direct or indirect, against its own people. The lowest rating is given to a country embroiled in an ongoing civil war. The risk rating assigned is the sum of three subcomponents, each with a maximum score of 4 points

[93] Employing the political violence/stability measure restricts the sample to 119 countries and the time span to the period of 1984-2010. Moreover, due to lack of the data for some countries for which data on political violence and civil conflict onset is available, the price shocks and conflict analysis was constrained to the sample of 77 countries.

and a minimum score of 0 points. The subcomponents are civil war/coup threat, terrorism/political violence and civil disorder.

The analysis also includes the additional set of control variables taken from the empirical growth literature: trade openness measured as the sum of exports and imports of goods and services as a share of GDP; inflation computed as the log of 1 plus the annual consumer price inflation rate, where data for both controls is collected from the World Bank Development Indicators (WDI); and international reserves (from IFS series 1..SZF) over GDP (from PWT 7.1).[94]

Table 5-1 provides summary statistics for growth rates, political contestability and violence/stability levels, and probability of conflict onset over the different subsamples according to countries' income (Panel A) and resource dependence levels (Panel B).[95] Two features of these statistics are of particular interest for the analysis. The first aspect is the tendency that higher income level countries tend to enjoy relatively rapid growth, better institutional quality and experience relatively less (higher) political violence (stability) and conflict. Average statistics of growth rates (conflict onset) increase (decrease) when moving from the lower to higher income classifications: from 1.698% (0.049) for low-income countries to 1.739% (0.035) for high-income countries. Furthermore, the lower (higher) income level countries are on average more autocratic (democratic) and likely to suffer from unstable political environment: average statistics of *polity2* (political stability) increases from -0.371 (7.976) to 5.662 (10.07) when moving from the lower to higher income classifications. The second facet of these statistics is that relatively low resource dependent countries are likely to lie down on the upper-half (more democratic) of autocracy-democracy spectrum and enjoy relatively higher political

[94] Following the upper and lower bound restrictions offered by Roodman (2006), the analysis treats commodity price index (and all its interactions), *polity2*, political violence, trade openness and international reserves ratios as endogenous, while other variables employed in the specifications as predetermined.

[95] The cut-off levels for low and high-half income groups are taken as in DeJong and Ripoll (2006), where country classifications are obtained by mapping classification thresholds as defined by the World Bank's income measures into the corresponding Penn World income measures. The resulting definitions are as follows: high-half income countries are those with real per capita GDP above $5,500; and low-half income countries are those with real per capita GDP less than $5,499. All classifications are based on the beginning sample income rankings. The threshold for the low and high resource dependence levels are defined as countries with net export shares below and above the 75th percentile of the distribution respectively.

stability: average statistics of *polity2* (political stability) decreases from 2.408 (8.784) to -1.284 (8.585) when moving from the lower to higher resource dependent countries.

Figure 5-1 plots how average cross-country political violence/stability levels change across political regime types. In order to do so, all observations are divided into eight bins depending on the value of *polity2*, where bin sizes are chosen to have as uniform as possible a sample size across bins, while at the same time preserving the symmetry between “autocratic” and “democratic” bins. The resulting intervals of the eight bins are for the average *polity2* values [-10,-8], [-8,-5], [-5,-3], [-3, 0], [0, 3], [3, 5], [5, 8] and [8, 10] respectively.[96] Three features are of note. The first is that for deeply entrenched autocracies (interval of [-10,-8]) the average political stability is above the mean illustrating low variation in political violence. The second facet of these statistics is that average political stability rapidly jumps down below the mean when moving from deeply to less entrenched autocracies reaching its minimum average value and maximum variation range for the [-5,-3] interval which also demonstrates similar behaviour for the [-3, 0] interval. The third aspect is the intuitive tendency that the average political stability gradually increases when moving from less democratic to highly democratic subsamples.[97]

5.3. Empirical Results

Aforementioned, the previous literature suggests that income shocks generated by resource windfalls might have a heterogeneous impact on growth conditional on a country’s governance level. In particular, Collier and Goderis (2009) adopting a panel co-integration methodology show that resource shocks have an unconditional positive association with growth in the short run, however an increase in commodity price *levels* may lead to slower growth in the long run conditional on poor

[96] It is of note that none of the countries in the data set lay on bounds of average *polity2* level intervals. Moreover, since the number of countries with available political violence data is severely low for deeply entrenched autocracies, the convention of the overlapping intervals is preferred during the analysis in order to be able to achieve as large as possible number of observations for small sample sized bins.

[97] The average political stability across democratic bins drastically decreases showing wide variation in political violence only for the [5, 8] interval which is mainly driven by the presence of three countries: Colombia, Peru and Sri Lanka. Eliminating these countries from the subsample illustrates a monotonic increase (decrease) in average political stability (violence) levels when moving from less democratic to highly democratic bins.

governance, which itself is heterogeneous across different type of commodities.[98] A simple illustration of how the impact of resource windfalls on economic growth can vary across countries with different income levels, presented in Figure 5-2, indeed provides support for this view.[99] The plots illustrate a significant positive impact of resource windfalls on growth only for the high-half income subsample, while this effect is insignificant on average across the lower income distribution subsample, perhaps reflecting a contradictory effect induced by institutional quality and political instability, which signifies how economic and political factors may have played a role in the disappointing performance across resource-intensive economies.

The role of political institutions (and institutional quality more broadly) in explaining the cross-country differences in income levels and economic performances (see e.g., Acemoglu *et al.*, 2005),[100] as well as how resource abundance might affect institutional quality has been largely explored in the literature. A particularly interesting study for the analysis in this paper is the recent work by Caselli and Tesei (2011) where the authors document how a country's political institutions respond heterogeneously to the changes from natural resource windfalls. Specifically, the results reveal that resource windfalls have no political

[98] The replication analysis of these relationships is demonstrated in Appendix Table 5-A1. Although the analysis in this paper does not purport to test the short-run and long-run impacts of resource windfalls on growth, by replicating Collier and Goderis (2009) results using the preferred measurement, the investigation confirms the original findings that the impact of commodity price levels on growth can vary in the long-run and across different commodity types. In particular, the replication results demonstrate that short-term effects of commodity price shocks are always positive and illustrate strong quantitative significance with growth. Decomposing the composite commodity export price index levels into point vs. diffuse and energy vs. non-energy source commodities illustrates that the negative and statistically significant long-run effects might occur only in point source and energy source commodity exporting countries. This effect instead is more likely not to be detrimental for diffuse and non-energy source commodity exporting countries. For the more detailed analysis regarding using co-integration techniques, its requirements, non-linearity results, please see Collier and Goderis (2009).

[99] Scatter plots and fitted relationships between the variables of interest for low and high-half income groups are achieved using partial regressions which are obtained in two stages. First, both the dependent variable and the isolated independent variable are projected onto the additional set of regressors under consideration. Next, the residuals of the dependent variable are regressed against the residuals of the independent variable. The figures are produced using least squares regressions where growth and commodity price shocks are related linearly.

[100] See also Sirimaneetham and Temple (2009) who argue that instability can form a binding constraint on economies' growth rates, where for the more stable countries, the measures of institutional quality have more explanatory power on economic performance, i.e. fundamentals for growth such as good institutions are not strongly associated with higher economic performance unless stability is also in place.

consequences when they occur in democracies. However, in autocracies, the changes in the flow of resource rents make the political regimes more autocratic. Moreover, in autocracies the increase in autocracy following an increase in resource revenues is diminishing in the initial level of autocracy, i.e. the less autocratic the form of government was initially.[101] Further analysis by Caselli and Tesei (2011) also reveals the fact that in autocracies the negative impact from resource windfalls is mainly driven by moderately entrenched autocracies, while in deeply entrenched autocracies this effect on politics is virtually nil confirming the importance of within-country political violence/stability levels in shaping a country's political institutions.[102]

The analysis of how the impact of resource windfalls on conflict can be dependent on these interactions between political institutions and political violence are presented in Table 5-2. Table 5-3 instead addresses the issue of how these relationships are reflected onto the economic growth. The subsequent Tables 5-4 – 5-8 report a number of sensitivity checks on the results from Table 5-3. In particular, the analysis explores the robustness of the results to: alternative criteria for inclusion of countries in the sample based on (i) importance of the shares from natural resource rents in the economy; (ii) dropping large commodity producers; (iii) dropping subsets of countries for certain aspects of their political contestability levels and (iv) their political violence experiences; (v) breaking down the resource wealth by commodity type.

5.3.1. Resource Windfalls and Conflict Onset

The conjecture of this investigation follows the idea that the impact of resource windfalls on conflict outbreak is a non-linear function of a country's political institutions and effective political violence/threat posed by internal forces

[101] The main findings from Table 3 (columns 3 and 4) as in Caselli and Tesei (2011) are replicated in Appendix Table 5-B2 (columns 1 and 2). Appendix 5-B provides more detailed information on the replication analysis. For more detailed analysis regarding the relationship between natural resource windfalls and political system, please refer to the original paper.

[102] In addition to the replication exercise, the analysis also estimated the non-linear relationship between price shocks and political system conditional on initial political violence/stability levels (columns 3 and 4 in Appendix Table 5-B2). The results provide supportive evidence for the original findings and are consistent with Figure 1, confirming that price shocks significantly exacerbate political system only in politically unstable autocracies and have no impact on politics when they occur in democracies and in politically stable autocracies. For more detailed information regarding this investigation, please see Appendix 5-B.

(incumbent government vs. opposition group). Alternatively, in the presence of a stable socio-economic and political environment and cohesive institutions, resource windfalls have no impact on conflict onset. However, for countries with non-cohesive institutions and unstable political background, the impact of resource windfalls on conflict depends on the threat level that incumbent government/opposition group faces. Specifically, if the initial within-country violence level is high, an increase in resource windfalls is expected to increase the investment into self-preservation activities and hence state capacity, and therefore decrease conflict possibility by reducing incentives of potential opposition groups to confront the incumbent government. However, if the initial threat/violence level is relatively low (or the chance of opposition group to be successful and replace the incumbent government is relatively high), an increase in resource windfalls is expected to increase the incentives of opposition group by raising the gains from appropriation, and therefore increase the conflict possibility. The overall impact from the cross-country analysis will also vary on the relative strength of the two effects within violence groups.

Estimation results of the resource-conflict link analysis are presented in Table 5-2. The first column derives this relationship linearly where civil conflict onset responds to the changes in commodity price index, controlling for country and time fixed effects. The results are similar to those found in the existing literature where the risk of civil conflict outbreak is higher when the change in price of export commodity index drops. The statistically significant effect implies that a one standard deviation drop in countries' commodity price indices is associated with an increase in the probability of a civil conflict onset of about 0.67 percentage points.[103]

The subsequent two columns estimate this relationship non-linearly using the following strategy. Firstly, the specification in column 2 adds the initial level of political violence/stability both, by itself and interacted with price index change; while column 3 runs the same exercise by separating the change in price index into two variables according to the initial political contestability level: the first is an interaction between the change in the price index and a dummy for democracy and the second is an interaction with dummy for autocracy.

[103] These measures are obtained by multiplying the coefficient estimate by average standard deviation of 0.011, and then multiplying by 100 to convert to a percentage-point measurement.

The results from the non-linear estimation of these relationships provide support for the conjecture, and indicate that positive shocks in commodity prices have an even larger negative direct impact on conflict outbreak in politically violent countries. The coefficients on the interaction terms are significant and positive in all cases, implying a positive marginal impact of resource windfalls while within-country political threat level decreases. Stratifying this association for countries with autocratic/democratic regime types reveals that the significant consequences from price shocks are present only in autocratic countries, while resource windfalls have no impact on conflict possibility when they occur in democracies.

As a check on the results, the last column re-estimates the effect of price shocks for the subsamples below and above the average political stability level.[104] In order to do so, the change in commodity price index interaction with continuous political violence/stability variable is replaced by the price shocks interacted with a dummy that takes the value of unity if a country's initial political stability level is above the sample mean, and zero otherwise. Interpretation of the coefficient estimates is as follows: if the findings above are true, then the direct impact of changes in price index (referring to high violence level countries) should be negative, and the coefficient on interaction term (referring to relatively low violence level countries) should be positive. Moreover, in order to have a total positive impact on conflict for the subsample with a relatively stable political environment, the coefficient of the latter should be significantly larger in absolute value than the former, representing the *deviation* of price shock effects from the reference subsample with high violence levels.[105]

The results from this exercise are consistent with the findings above where the risk of civil conflict outbreak is significantly higher only for autocracies with a politically violent environment when the change in price of export commodity index drops. The interaction term is positive illustrating that the effect of price shocks for relatively

[104] Since the investigation does not reveal any differential impact of resource windfalls for democratic countries, the specification in column 4 does not break up the democracy specific price index into violence level categories.

[105] It can be easily checked that this is equivalent to including the interactions of price shocks with both dummies for high and low violence level subsamples. However, the implementation of the specification in column 4 has the advantage of demonstrating whether the price shock effects for relatively stable countries significantly differ from the reference group with high violence levels, at the same time enabling us to distinguish whether these effects are significantly different from zero.

low violence level countries significantly deviates from the effect for the reference group with high political threat levels. The associated quantitative significance of one standard deviation increase in price shocks from splitting the data set into subsamples is estimated as -2.28 percentage points among high threat level countries. The magnitude of interaction term implies that this effect is positive, albeit on average, is not significantly different from zero for relatively stable autocracies.

In a further effort to probe whether this heterogeneity for price shock effects is somehow different across infra-marginal changes in political regimes, Figure 5-3 plots the estimated coefficients of high and low violence specific changes in commodity price index along with their relative confidence bands (at 95% level) for each bin given the exclusion of potential outliers.[106] For ease of comparison of the price change estimates, the conflict equation is re-estimated using two interactions of price shocks (always controlling for country and time fixed effects): one with a dummy for high violence levels illustrated with red colour; and other with a dummy for relatively low violence levels illustrated with blue colour.

The estimation results of high and low violence specific changes in commodity price index for democratic countries are consistent with the findings from Table 5-2 confirming that, on average, resource shocks do not have significant consequences on conflict possibility when they occur in countries with cohesive institutions. Considering the impact of these shocks across infra-marginal changes for autocracies instead provides further intriguing results. For deeply entrenched autocracies, the impact of price shocks on conflict is virtually nil. Moving from deeply to moderately entrenched autocracies reveals a positive impact (significant at 10% level) of price shocks for relatively low threat level countries in the [-8,-5] interval, which in turn demonstrates strong quantitative significance (at 1% level) when the subsample in the [-5,-3] interval is considered. For the least entrenched autocracies (interval of [-3, 0]) with high political threat levels instead, the positive shock to price changes significantly decreases the probability of conflict outbreak.[107] It is also of emphasis

[106] The potential outlier countries are identified as those associated with the combination of experiencing the highest frequency of high and low political violence within each violence group for each bin.

[107] The associated quantitative significance of one standard deviation increase in price shocks for the subsample in the [-5,-3] ([-3, 0]) interval is estimated as 3.38 (-6.41) percentage points among relatively low (high) threat level countries.

that in all cases across the bins, relatively lower initial political threat levels within subsamples provides relatively less opportunity cost for conflict possibility compared with high initial threat level countries, which supports the hypothesis that the marginal impact of price shocks on conflict outbreak is increasing while political violence level decreases. These results also suggest that average insignificant price shock effect on conflict for relatively low violence level autocracies in Table 5-2 (column 4) is driven by the fact that two opposing effects cancel each other out.

Altogether, these findings demonstrate that (i) there is an absence of evidence between resource windfalls and conflict outbreak for democracies and for stable autocracies (as in e.g., Bazzi and Blattman, 2011); (ii) there is a positive association for unstable autocracies if initial political violence level is relatively low (as in e.g., Collier and Hoeffler, 1998; Besley and Persson, 2008); and a negative association if an unstable autocratic country's political violence level is high (as in e.g., Brunnschweiler and Bulte, 2009; Bruckner and Ciccone, 2010).

5.3.2 Resource Windfalls and Growth

The analysis now turns to the exploration of the impact of resource shocks on economic growth with an emphasis on the importance of political institutions and within-country political violence levels to explain this relationship. The supposition for the growth analysis is that resource wealth is associated with higher economic performance only for countries with stable socio-economic and political environment, while significantly undermining growth for unstable countries with non-cohesive political institutions.

The estimation results for this analysis are presented in Table 5-3. The first column derives this relationship linearly where growth responds to the changes in commodity price index in the presence of additional control set. The results are consistent with the existing literature where a positive shock from resource windfalls is associated with higher economic growth. The statistically significant effect implies that a one standard deviation increase in commodity price index is associated with an increase in income per capita growth of about 0.36 percentage points.

The approach to capture the non-linear relationship between resource windfalls and growth conditional on political institutions and within-country political violence levels is twofold. Under the first (column 2), the specification, in addition to separating the resource shocks into autocracy/democracy specific price change index according to a country's initial political contestability levels, also includes the initial level of *polity2* (interacted with an autocracy dummy), both by itself and interacted with the autocracy specific price change index, enabling us to estimate how price shock effects on growth vary when moving from deeply to moderately entrenched autocracies, given the amplification of political violence in this direction.[108] The second approach (column 3) instead applies the same strategy as in column 4 in Table 5-2 in presence of an additional control set to estimate how the relationships between resource windfalls, political regimes and violence are reflected in economic growth.

The estimation results demonstrate that for democracies resource windfalls are positively associated with growth, while in autocracies this association is generally negative and diminishing in the initial level of autocracy, i.e. an increase in the price change index is more detrimental for growth in relatively unstable autocratic regimes. Stratifying this association into high and low violence levels reveals that resource windfalls are harmful to economic growth only for autocracies with high political violence levels, while this association is positive if within-country political threat level is low. Regarding quantitative significance, the impact on growth of a one standard deviation increase in the commodity price index change is estimated to be 1.09 percentage points among democracies, -0.81 percentage points for high within-country threat level (unstable) autocracies, and 0.33 percentage points among low within-country threat level (stable) autocracies.[109]

Coefficient estimates of additional explanatory variables also enter with the expected signs. Estimated coefficients on initial levels of income and inflation rate are negative, statistically significant, and indicate strong quantitative effects. Trade

[108] The inclusion of an interaction term between democracy specific price change index and the initial level of *polity2* (interacted with a democracy dummy) again does not reveal significant differential impact of resource windfalls on growth, also illustrating insignificant interaction effect when the democracy specific price change is stratified into political threat categories (results available upon request). Therefore, the specifications during the rest of analysis omit any interactions of democracy specific price change index.

[109] The impact of resource windfalls on growth for low threat level autocracies are calculated by summing the autocracy specific price shock estimates (-0.732 + 1.033), multiplying by average standard deviation of 0.011, and then multiplying by 100 to convert to a percentage-point measurement.

openness and international reserves ratios are always positive and typically exhibits a strong relationship with growth.

In summary, the findings show that an increase in commodity price *shocks* are positively associated with economic performance in democracies and in politically stable autocracies, while significantly undermining growth for politically unstable autocracies. Thus the analysis confirms that, despite the arguments in the literature, resource windfalls can lead to slower growth conditional on poor governance of resource revenues.

5.3.2.1. Robustness Checks

Table 5-4 examines the robustness of the results estimated for the relationship between price shocks and growth for the approaches in columns 2 and 3 of Table 5-3 to the exclusion of countries whose resource wealth accounts for only a small share of GDP. For these countries it is less likely that price changes would represent large windfalls, and hence would not provide motivation to engage in self-preservation activities or oppose the incumbent government, thus focussing on a sample with larger commodity shares is arguably a better test for the sensitivity of the results. Columns 1 and 2 exclude countries in the first decile of the average share distribution (respectively, 13 and 11 countries); columns 3 and 4 exclude countries in the first quartile (35 and 30 countries); and columns 5 and 6 exclude all countries below the median average share (69 and 59 countries). Despite the significant drop in the sample size, the results from baseline sample remain robust at least at the 10% significance level in all cases and are generally reinforced as the threshold to be included in the sample progressively increases. In particular, the point estimates for the autocracies (democracies) in columns 1, 3 and 5 (columns 2, 4 and 6) become more (less) negative (positive) as the analysis focuses on more resource dependent countries.

Table 5-5 addresses the reasonable concern that commodity prices can be affected by expectations of economic and political developments in the main world producers, and hence shaping the decision-making process of incumbent government regarding to make an investment into self-preservation activities, especially in places where politics is the only road to riches. The investigation therefore excludes from the sample three subsets of countries: (i) those belonging to OPEC; (ii) big energy producers; (iii) and large commodity producers accounting for significant shares of total world production.[110] In all cases, the results remain robust at least at the 10% significance level with coefficient estimates of the variables of interest lying mostly within one standard deviation of the full sample estimate.

The potential influence on the results of several additional subsets of countries is also considered. The collection of these subsets reflects countries singled out due to their resource dependence and political violence experiences across autocracy/democracy spectrum during the time period spanned by the sample. The results of this exercise are illustrated in Tables 5-6 and 5-7. For each subset, Tables 5-6 and 5-7 report the list of countries, their 1990 net export shares, political contestability and violence levels, growth rates measured over the sample period, and the coefficient estimates of variables of interest as specified above for the first and the second approach.

Table 5-6 checks the sensitivity of the results under the first approach to the exclusion of resource abundant countries resting at the top and bottom of the autocracy/democracy spectrum. The results of this exercise are demonstrated for two subsets of countries with high net export shares (above the 75th percentile): (i) countries placed at the bottom quartile of political contestability level; (ii) and countries located at the top quartile of the autocracy/democracy spectrum. The coefficient estimates of the variables of interest change very little given the removal of any one of the subsets under consideration, lying within one standard deviation of the full sample estimates. What does change somewhat is the statistical significance of the interaction term with initial autocracy specific political contestability level in the case when the exclusion of the first subset is employed.

The second collection of subsets includes countries singled out due to their political violence experiences among autocratic economies located at the bottom quartile of

[110] The investigation treats Indonesia as an OPEC country, as it belonged to the organisation almost during the whole sample period, but excludes Angola and Ecuador who joined the OPEC in 2007, and Gabon who was a member of the OPEC only for the period of 1975-1994. Alternative treatments of these countries do not alter the results. Big energy (oil, natural gas, gasoline, uranium and coal) producers reflect countries whose principal net export commodity production share accounts for more than 2.5% of total world supply. The list of large commodity producers instead captures all countries whose principal net export commodity production share belongs to the list of top 15 biggest producers (according to the latest estimates) in the world by commodity. Please see Appendix Table 5-B3.

autocracy/democracy spectrum, whose net exports accounts for above the mean of GDP share. Two subsets are considered: the 11 autocratic countries with high political violence levels specified as those below the mean; and the 10 relatively stable autocracies with political violence levels above the mean. The impact of removing these subsets of countries under the second approach is reported in Table 5-7. Once again, point estimates are not altered greatly, lying within 1.5 standard deviations of the full sample estimates, although showing some sensitivity for statistical significances across subsets. Overall, the general pattern of results reported in Table 5-3 remains apparent given the exclusion of both collection of countries from the sample.[111]

Collectively, the results from Tables 5-4 – 5-7 suggest that the non-linear relationship between commodity price shocks and growth does not seem attributable to just a number of exceptional countries exerting a large influence.

Table 5-8 deals with the issue of commodity typology. An important distinction that has been made in the literature is the role of point and energy source commodities (e.g., Isham *et al*., 2005; De Soysa and Neumayer, 2007), which is believed to induce a higher risk of conflict, foster weaker institutional capacity and provide higher pay-offs from non-productive lobbying and rent-seeking activities, as they are generally more valuable. Therefore columns 1-2 and 3-4 break down the change in commodity price index, respectively, into point and energy sources. Although, the significances for energy source commodity price index change show some sensitivity across specifications, the coefficient estimates of the variables of interest change little lying within one standard deviation of the full sample estimates. Overall, the general pattern of results is consistent with findings reported in Table 5-3.[112]

5.4. Conclusion

The empirical analysis has confirmed that the impact of resource windfalls on economic growth, political system and conflict depends on government performance

[111] An analogous analysis employing the sample restrictions as in Table 5-6 (Table 5-7) under the second (first) approach is also considered where the results remain robust at least at the 10% significance level in all cases (available upon request).

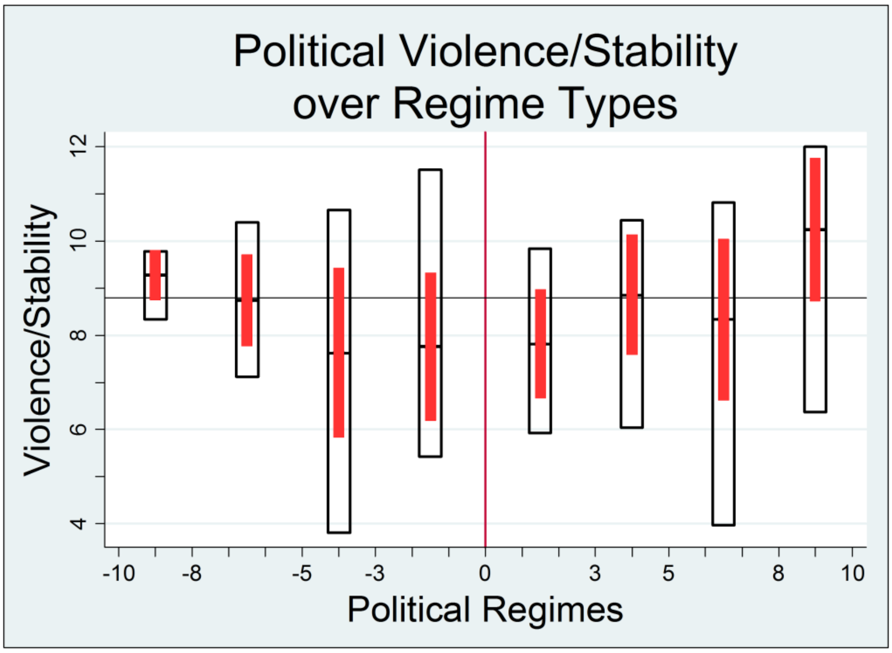
[112] An analogous analysis has been carried for diffuse and non-energy source commodity exporting countries. The findings reveal that the price shocks are not detrimental within autocracies typically illustrating insignificant impact on growth (available upon request).

and can lead to slower growth, bad institutions and higher conflict potential if the additional revenues from resource shocks are not being spent productively.

The investigation has illustrated that institutional quality and within-country political violence/stability levels, to a large extent, are able to explain the ambiguity behind the contradicting results in the resource literature. In particular, reassessing the price shock effects on conflict outbreak, the analysis has shown that the resource windfalls have no significant consequences in democracies and in politically stable autocracies. In contrast, for politically unstable autocracies, the significant impact from resource windfalls is conditional on a country's initial political violence level. Specifically, a positive shock to an autocratic country's flow of resource rents with high political threat levels decreases conflict possibility, while leading to higher potential for violence if within country political threat level is relatively low.

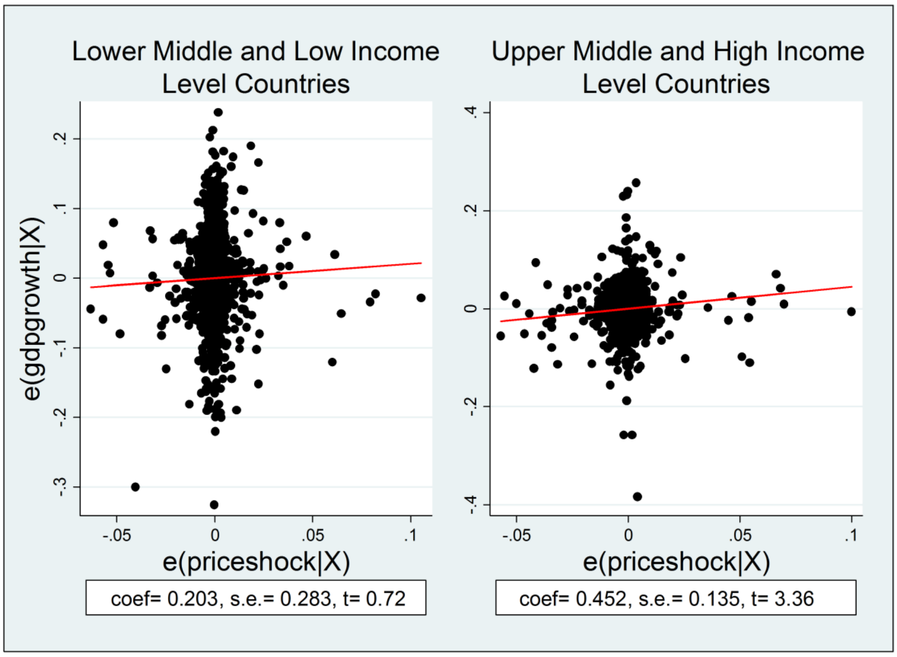
The investigation has also contributed to the growth literature showing that resource *shocks* are positively associated with growth in democracies and in politically stable autocracies, while undermining a country's economic performance for politically unstable autocracies.

Figure 5-1: Summary of Political Violence over Political Regime Types



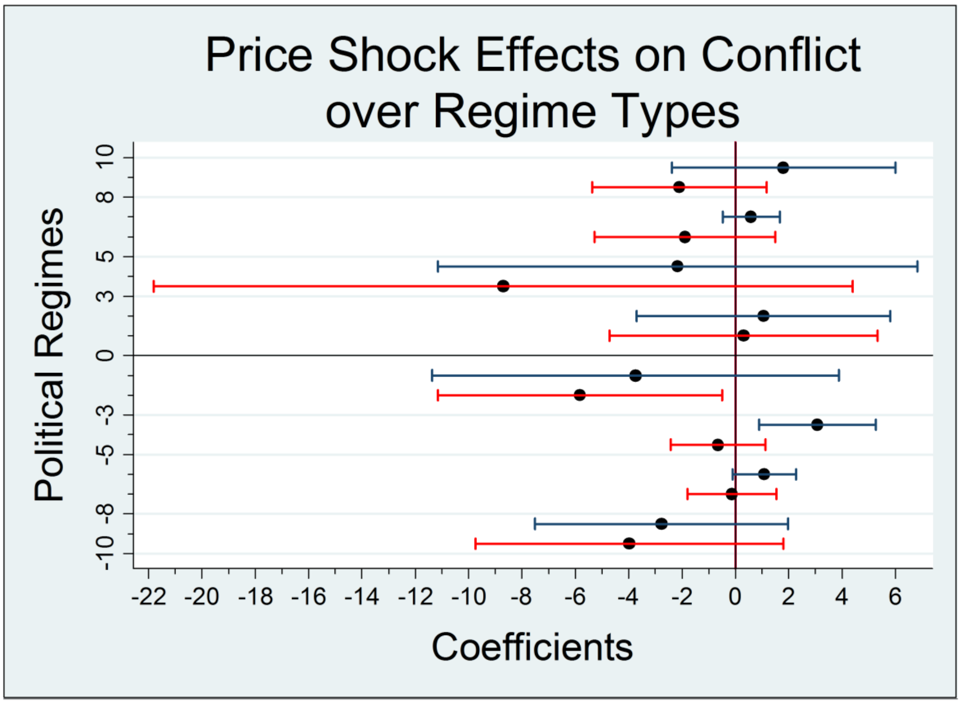
Note: Respective cross-country average statistics of political violence/stability over political regime types are summarized for the period of 1984-2010 and a sample of 119 countries. Red bars represent average mean of political violence ± one standard deviation, while empty bars correspond to its maximum and minimum value in each interval. Mean line of political violence corresponds to the value of 8.7. The number of observations for eight intervals when moving from "autocratic" to "democratic" bins is 6, 8, 14, 12, 12, 9, 25 and 33 respectively.

Figure 5-2: Partial Regression Plots for Commodity Price Shocks and Growth



Note: The set of regressors includes initial levels of logged income, trade openness, log of inflation rate, international reserves ratio, country and time-specific fixed effects. The figures are produced using OLS regressions.

Figure 5-3: Estimated Coefficients of Price Shocks on Conflict at Different Bins



Note: The graph plots the estimated impact of high and low violence specific price shocks on conflict conditional on initial *polity2* levels for each bin. Red spikes represent 95% confidence bands for high violence specific price shock estimates, while confidence intervals for low violence sample are illustrated with blue colour. The bins are constructed so to maintain the symmetry around the zero threshold, while maximising the number of observations and minimizing the differences in frequency across them. The number of observations for eight intervals when moving from "autocratic" to "democratic" bins is 110, 357, 134, 103, 88, 124, 327 and 426 respectively. The eliminated countries for the 1st bin are Oman and Syria; 2nd bin China and Cameroon; 3rd bin Gabon and Sudan; 4th bin Gambia and Guinea; 5th bin Mali and Pakistan; 6th bin Malaysia and Lebanon; 7th bin Argentina and Columbia; 8th bin Australia, France, Netherlands, Portugal, United Kingdom, United States and Israel. The method of estimation is the least squares with robust standard errors clustered by country.

Table 5-1: Descriptive Statistics for Growth, Political Regimes, Political Violence and Conflict Onset

Sample split	Variable	Observations	Mean	Std. Dev.
		Panel A: Income levels		
Lower Mid./Low	Growth	89	1.698	6.579
	Polity2	89	-0.371	6.684
	Violence/Stability	74	7.976	2.474
	Conflict Onset	59	0.049	0.216
High/Upper-Mid.	Growth	46	1.739	7.079
	Polity2	46	5.662	7.114
	Violence/Stability	45	10.07	1.972
	Conflict Onset	18	0.035	0.185
		Panel B: Resource Dependence levels		
Low	Polity2	101	2.408	7.185
	Violence/Stability	89	8.784	2.551
High	Polity2	34	-1.284	7.248
	Violence/Stability	30	8.585	2.406

Note: Summary statistics for growth rates and *polity2* are based on country averages for the period of 1963-2010 and a sample of 135 countries. Political violence/stability and civil conflict onset statistics are restricted to the period of 1984-2010 and summarized for 119 and 77 countries data set respectively.

Table 5-2
Commodity Price Shocks and Conflict
Dependent Variable: Civil Conflict Onset

	(1)	(2)	(3)	(4)
Δ *Index*	-0.612*	-4.097*		
	(0.346)	(2.146)		
Δ *Index* $_{*}$ *Violence* $_{t-1}$		0.389*		
		(0.209)		
Δ *Index* $_{d}$			-8.254	-1.300
			(5.692)	(0.971)
Δ *Index* $_{a}$			-2.791*	-2.072**
			(1.585)	(0.969)
Δ *Index* $_{d*}$ *Violence* $_{t-1}$			0.849	
			(0.623)	
Δ *Index* $_{a*}$ *Violence* $_{t-1}$			0.256*	
			(0.149)	
Δ *Index* $_{a*}$ *Violence* $_{low}$				2.077***
				(0.763)
Violence $_{t-1}$		-0.004	-0.004	
		(0.004)	(0.004)	
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Countries/Observations	77/1709	77/1612	77/1597	77/1597

Note: ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. The method of estimation is least squares. Robust standard errors clustered by country are presented in the parentheses. The time span for the analysis is based on unbalanced dataset for the 1984-2010 period.

Table 5-3
Commodity Price Shocks and Growth
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	(1)	(2)	(3)
Initial GDP p.c. (log)	-0.043**	-0.167**	-0.078***
	(0.022)	(0.068)	(0.015)
Trade openness	0.022*	0.026	0.021**
	(0.012)	(0.038)	(0.011)
Inflation (log)	-0.031***	-0.034***	-0.014**
	(0.011)	(0.013)	(0.006)
Reserves/GDP ratio	0.179**	0.317***	0.088
	(0.072)	(0.111)	(0.056)
Δ *Index*	0.326**		
	(0.151)		
Δ *Index* $_{d}$		0.756**	0.995***
		(0.349)	(0.351)
Δ *Index* $_{a}$		-0.757**	-0.732***
		(0.338)	(0.215)
Δ *Index* $_{a*}$ *Pl* $_{t-1,a}$		-0.129**	
		(0.058)	
Δ *Index* $_{a*}$ *Violence* $_{low}$			1.033***
			(0.262)
Pl $_{t-1,a}$		-0.011**	
		(0.005)	
Country FE	YES	YES	YES
Time FE	YES	YES	YES
Countries/Observations	135/4337	135/4324	119/2428
Specification tests			
(a) Hansen Test:	0.561	0.723	0.976
(b) Serial Correlation:			
First-order	0.000	0.000	0.000
Second-order	0.569	0.237	0.260

Note: The time span for the analysis in columns 1 and 2 is based on unbalanced dataset for the 1963-2010 period (T=47), while in column 3 for the 1984-2010 period (T=26). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 5-4
Excluding Low Export Share Countries
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Above 1st Decile Share		Above 1st Quartile Share		Above Median Share	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (log)	-0.111**	-0.068**	-0.127**	0.126***	-0.134**	-0.129***
	(0.049)	(0.030)	(0.052)	(0.025)	(0.057)	(0.035)
Δ *Index$_d$*	0.944**	0.967**	0.901**	0.962**	0.912**	0.625**
	(0.402)	(0.369)	(0.401)	(0.383)	(0.395)	(0.236)
Δ *Index$_a$*	-0.777***	-0.698**	-0.803***	-0.762***	-0.812***	-0.622*
	(0.206)	(0.315)	(0.212)	(0.236)	(0.219)	(0.334)
Δ $Index_{a}*Pl_{t-1,a}$	-0.159***		-0.163***		-0.164***	
	(0.031)		(0.033)		(0.034)	
Δ $Index_{a}*Violence_{low}$		0.904**		1.052***		0.829**
		(0.372)		(0.296)		(0.409)
$Pl_{t-1,a}$	-0.007*		-0.009**		-0.011**	
	(0.004)		(0.004)		(0.005)	
Control Set	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Countries/Observations	122/3885	108/2214	100/3268	89/1810	66/2122	60/1190
Specification tests						
(a) Hansen Test:	0.925	0.175	0.143	0.723	0.187	0.942
(b) Serial Correlation:						
First-order	0.000	0.000	0.000	0.000	0.000	0.001
Second-order	0.262	0.183	0.435	0.266	0.100	0.389

Note: In addition to the variables of interest reported above, all specifications employ an additional control set which includes initial levels of trade openness, log of inflation rate and international reserves ratio. Columns 1-2, 3-4 and 5-6 exclude countries below the first decile, the first quartile and the median of the average commodity export share distribution, respectively. The respective number of countries eliminated in columns 1 (2), 3 (4) and 5 (6) are 13 (11), 35 (30), and 69 (59). The time span for the analysis in columns 1, 3 and 5 is based on unbalanced dataset for the 1963-2010 period (T=47), while in columns 2, 4 and 6 for the 1984-2010 period (T=26). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 5-5
Excluding Big Producers
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Exclude OPEC Countries		Exclude Big Energy Producers		Exclude Large Commodity Producers	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (log)	-0.086***	-0.075***	-0.067**	-0.092***	-0.086*	-0.081***
	(0.031)	(0.016)	(0.029)	(0.017)	(0.045)	(0.019)
Δ *Index$_d$*	0.596*	0.907**	0.966**	1.239***	0.974*	1.695***
	(0.339)	(0.424)	(0.403)	(0.463)	(0.535)	(0.449)
Δ *Index$_a$*	-0.682**	-0.711**	-0.449*	-0.674**	-0.458*	-0.654**
	(0.339)	(0.322)	(0.234)	(0.297)	(0.262)	(0.294)
Δ $Index_{a}*Pl_{t-1,a}$	-0.175***		-0.101***		-0.105**	
	(0.068)		(0.038)		(0.049)	
Δ $Index_{a}*Violence_{low}$		0.938*		0.924**		0.944**
		(0.476)		(0.401)		(0.393)
$Pl_{t-1,a}$	-0.003		-0.003		-0.009	
	(0.002)		(0.002)		(0.006)	
Control Set	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Countries/Observations	124/4088	108/2267	118/3829	102/2118	72/2155	59/1140
Specification tests						
(a) Hansen Test:	0.752	0.169	0.313	0.234	0.257	0.982
(b) Serial Correlation:						
First-order	0.000	0.000	0.000	0.000	0.000	0.000
Second-order	0.817	0.537	0.710	0.451	0.339	0.880

Note: In addition to the variables of interest reported above, all specifications employ an additional control set which includes initial levels of trade openness, log of inflation rate and international reserves ratio. The time span for the analysis in columns 1, 3 and 5 is based on unbalanced dataset for the 1963-2010 period (T=47), while in columns 2, 4 and 6 for the 1984-2010 period (T=26). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 5-6
Exclusion of Countries with Unusual Characteristics
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	1990 Net Export Share	Average Polity2	Average Political Violence	Average Growth Rate	Coeff.	S. E.	p value
Remove Autocratic (<25th percentile) Countries with High Commodity Export Shares							
Algeria	0.11	-5.67	6.68	0.02			
Cameroon	0.12	-6.15	7.12	0.004			
Congo, Rep.	0.35	-5.19	7.89	0.02			
Cote d'Ivoire	0.24	-6.13	8.52	0.01			
Gabon	0.33	-4.67	9.36	0.01		**Δ *Index$_d$***	
Iran	0.07	-5.81	7.59	0.02	0.803	0.402	0.048
Kuwait	0.28	-7.6	8.86	0.01		**Δ *Index$_a$***	
Libya	0.29	-7	8.90	-0.02	-0.545	0.251	0.032
Malawi	0.09	-3.77	7.59	0.01		**Δ *Index$_a$*Pl$_{t-1,a}$***	
Mauritania	0.23	-6.10	N/A	0.03	-0.126	0.088	0.152
Oman	0.36	-9.29	9.78	0.03			
Qatar	0.29	-10	9.58	0.04			
Saudi Arabia	0.27	-10	8.96	0.001			
Swaziland	0.08	-8.83	N/A	0.02			
Syria	0.08	-8.25	9.52	0.01			
Remove Democratic (>75th percentile) Countries with High Commodity Export Shares							
						Δ *Index$_d$*	
Mauritius	0.09	9.67	N/A	0.03	0.627	0.351	0.076
New Zealand	0.08	10	11.79	0.01		**Δ *Index$_a$***	
Trinidad & Tobago	0.08	8.85	8.71	0.03	-0.649	0.170	0.000
Venezuela	0.16	7.35	9.19	0.004		**Δ *Index$_a$*Pl$_{t-1,a}$***	
					-0.137	0.029	0.000

Note: In addition to the variables of interest reported above, all specifications control for initial levels of logged income, trade openness, log of inflation rate, international reserves ratio, autocracy specific *polity2*, country and time-specific fixed effects. The number of countries/observations for each panel is, respectively, 120/3884 and 131/4203. The time span for the analysis is based on unbalanced dataset for the 1963-2010 period (T=47). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 5-7
Exclusion of Countries with Unusual Characteristics
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	1990 Net Export Share	Average Polity2	Average Political Violence	Average Growth Rate	Coeff.	S. E.	p value
Remove Resource Dependent Autocratic Countries with High Political Violence Levels							
Algeria	0.11	-5.67	6.68	0.02			
Angola	0.30	-3.23	5.34	0.04			
Bahrain	0.07	-8.98	8.33	0.001		**Δ *Index_d***	
Cameroon	0.12	-6.15	7.12	0.004	1.320	0.385	0.001
Congo Rep.	0.35	-5.19	7.89	0.02		**Δ $Index_a$**	
Cote d'Ivoire	0.24	-6.13	8.52	0.01	-0.469	0.298	0.119
Iran	0.07	-5.81	7.59	0.02		**Δ $Index_{a*}$ $Violence_{low}$**	
Morocco	0.03	-7.38	8.41	0.03	0.771	0.297	0.011
Togo	0.06	-5.13	7.40	-0.001			
Uganda	0.05	-3.17	5.94	0.01			
Zimbabwe	0.27	-3.89	7.34	0.001			
Remove Resource Dependent Autocratic Countries with Low Political Violence Levels							
Gabon	0.33	-4.67	9.36	0.01			
Kazakhstan	0.04	-4.62	10.65	0.02			
Kuwait	0.28	-7.6	8.86	0.01		**Δ $Index_d$**	
Libya	0.29	-7	8.90	-0.01	1.109	0.357	0.002
Oman	0.36	-9.29	9.78	0.03		**Δ $Index_a$**	
Qatar	0.29	-10	9.58	0.04	-0.476	0.261	0.071
Saudi Arabia	0.27	-10	8.96	0.001		**Δ $Index_{a*}$ $Violence_{low}$**	
Syria	0.08	-8.25	9.52	0.01	0.684	0.447	0.129
Tunisia	0.03	-6.29	9.75	0.02			
Vietnam	0.09	-7	9.43	0.05			

Note: In addition to the variables of interest reported above, all specifications control for initial levels of logged income, trade openness, log of inflation rate, international reserves ratio, country and time-specific fixed effects. The number of countries/observations for each panel is, respectively, 108/2209 and 109/2297. The time span for the analysis is based on unbalanced dataset for the 1984-2010 period (T=26). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 5-8
Typologies of Commodities
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

	Point Source Commodity Price Index (1)	(2)	**Energy Source Commodity Price Index** (3)	(4)
Initial GDP p.c. (log)	-0.094**	-0.085***	-0.084**	-0.077***
	(0.037)	(0.019)	(0.035)	(0.025)
Δ $Index_d$	0.839**	1.323***	1.469*	0.849*
	(0.397)	(0.497)	(0.793)	(0.506)
Δ $Index_a$	-0.685**	-0.802***	-0.433	-0.684
	(0.270)	(0.245)	(0.294)	(0.494)
Δ $Index_{a*}Pl_{t-1,a}$	-0.115***		-0.124***	
	(0.040)		(0.037)	
Δ $Index_{a*}$ $Violence_{low}$		1.127***		0.804
		(0.302)		(0.625)
$Pl_{t-1,a}$	-0.004		-0.007*	
	(0.003)		(0.004)	
Control Set	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Countries/Observations	129/4161	116/2404	72/2292	68/1407
Specification tests				
(a) Hansen Test:	0.867	0.348	0.994	0.985
(b) Serial Correlation:				
First-order	0.000	0.000	0.020	0.011
Second-order	0.753	0.295	0.109	0.426

Note: In addition to the variables of interest reported above, all specifications employ an additional control set which includes initial levels of trade openness, log of inflation rate and international reserves ratio. The time span for the analysis in columns 1 and 3 is based on unbalanced dataset for the 1963-2010 period (T=47), while in columns 2 and 4 for the 1984-2010 period (T=26). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

References

Acemoglu, D., Aghion, P. and Zilibotti, F. (2006) Distance to Frontier, Selection, and Economic Growth. *Journal of the European Economic Association*, MIT Press, 4 (1), 37-34.

Acemoglu, D., Johnson, S. and Robinson, J. A. (2005) Institutions as the Fundamental Cause of Long-Run Growth, in Aghion, P. and Durlauf, S. (eds.). *Handbook of Economic Growth* (Amsterdam: North-Holland).

Acemoglu, D., Johnson, S., Robinson, J. A. and Yared, P. (2008) Income and Democracy. *American Economic Review*, 98 (3), 808-842.

Acemoglu, D. and Robinson, J. A. (2001) A Theory of Political Transitions. *American Economic Review*, 91 (4), 938-963.

Aghion, P., Bacchetta, P., Ranciere, R. and Rogoff, K. (2009) Exchange Rate Volatility and Productivity Growth: The Role of Financial Development. *Journal of Monetary Economics*, 56 (4), 494-513.

Aghion, P., and Howitt, P. (2005) Appropriate Growth Policy: A Unifying Framework. Harvard University-Brown University mimeograph.

Aizenman, J. and Glick, R. (2006) Military Expenditure, Threats and Growth. *Journal of International Trade and Economic Development* Vol 15, No. 2, 129-155.

Alcala, F. and Ciccone, A. (2004) Trade and Productivity. *Quarterly Journal of Economics*, MIT Press, 119 (2), 612-645.

Alexeev, M. and Conrad, R. (2009) The Elusive Curse of Oil. *The Review of Economics and Statistics*, 91 (3), 586-598.

Ali, H.E. and Abdellatif, O.A. (2013) Military Expenditure and Natural Resources: Evidence from Rentier States in the Middle East and North Africa. *Defence and Peace Economics*, DOI: 10.1080/10242694.2013.848574.

Angrist, J. and Kugler, A. (2008) Rural windfall or a new resource curse? Cocoa, income and civil conflict in Colombia. *Review of Economics and Statistics*, 90 (2), 191–215.

Arellano, M. and Bond, S. (1991) Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, 58:2.

Arellano, M. and Bover, O. (1995) Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68:1, 29-51.

Ashraf, Q. and Galor, O, (2007) Cultural Assimilation, Cultural Diffusion and the Origin of the Wealth of Nations. (CEPR Discussion Papers 6444).

Atkeson, A. and Kehoe, P. (2000) Paths of Development for Early and Late Bloomers in a Dynamic Heckscher-Ohlin Model. (Bank of Minneapolis Staff Report No. 256).

Auty, R. M. (2004) Natural Resources and Civil Strife: A Two-Stage Process. *Geoplitics*, 9, 29-49.

Auty, R. M. (1990) Resource-Based Industrialization: Sowing the Oil in Eight Developing Countries. Oxford University Press.

Baldwin, R. E., Martin, P. and Ottaviano, G. I. P. (2001) Global Income Divergence, Trade and Industrialization: The Geography of Growth Take-Offs. *Journal of Economic Growth*, 6, 5-37.

Baland, J. M. and Francois, P. (2000) Rent Seeking and Resource Booms. *Journal of Development Economics,* 61 (1), 527-542.

Ballantine, K. (2003) Beyond Greed and Grievance: Reconsidering the Economic Dynamics of Armed Conflict. Edited by K. Ballantine and J. Sherman, *The Political Economy of Armed Conflict: Beyond Greed and Grievance,* Lynne Riener, London.

Barro, R. and Lee, J.W. (1994) Losers and Winners in Economic Growth. *Proceedings of the World Bank Annual Conference on Development Economics,* Washington, D.C.: World Bank, 267-297.

Barro, R. J. and Sala-i-Martin, X. (1995) Economic Growth. Cambridge, MA: MIT Press.

Bazzi, S. and Blattman, C. (2011) Economic Shocks and Conflict: The (Absence of?) Evidence from Commodity Prices. Center for Global Development Working Paper 274.

Belsley, D.A., Kuh, E. and Welsch, R.E. (1980) Regression Diagnostics. New York: Wiley and Sons.

Ben-David, D. (1993) Equalizing Exchange: Trade Liberalization and Income Convergence. *Quarterly Journal of Economics*, 108, 3, 653-679.

Benoit, E. (1973) Defence and Economic Growth in Developing Countries. Boston: Heath and Co., Lexington Books.

Benoit, E. (1978) Growth and Defence in Developing Countries. *Economic Development and Cultural Change*, 26 (2), 271-80.

Besley, T. and Kudamatsu, M. (2008) Health and Democracy. *American Economic Review*, Papers and Proceedings.

Besley, T. and Persson, T. (2008) The Incidence of Civil War: Theory and Evidence. NBER Working Paper 14585.

Besley, T. and Persson, T. (2010) State Capacity, Conflict and Development. *Econometrica*, 78, 1–34.

Besley, T. and Persson, T. (2011) The Logic of Political Violence. *Quarterly Journal of Economics*, 126 (3), 1411-1445.

Bhagwati, J. (1998) *A Stream of Windows: Unsettling Reflections on Trade, Immigration, and Democracy.* (Cambridge: The MIT Press).

Bhargava, A., Jamison, D., Lau, L. and Murray, C. (2001) Modelling the Effects of Health on Economic Growth. *Journal of Health Economics*, 20 (3), 423-440.

Blundell, R. and Bond S. (1998) Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics* 87:1, 115-143.

Bougheas, S., Demetriades, P. and Morgenroth, E. (1999) Infrastructure, Transport Costs and Trade. *Journal of International Economics*, 47, 169-189.

Bourguignon, F. (2011) Introduction. *Journal of Development Economics*, 25, 7-11.

Brady, D., Kaya, Y. and Beckfield, J. (2007) Reassessing the Effect of Economic Growth on Well-Being in Less-Developed Countries, 1980-2003. *Studies in Comparative International Development*, 42, 1-35.

Bruckner, M. and Ciccone, A. (2010) International Commodity Prices, Growth and the Outbreak of Civil War in Sub-Saharan Africa. *Economic Journal*, 120 (544), 519-534.

Bruckner, M., Ciccone, A. and Tesei, A. (2012) Oil Price Shocks, Income, and Democracy. *Review of Economics and Statistics*, 94 (2), 389-399.

Brunnschweiler, C.N. (2008) Cursing the Blessings? Natural Resource Abundance, Institutions and Economic Growth. *World Development*, 36 (3), 399-419.

Brunnschweiler, C.N. and Bulte, E.H. (2008) The Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings. *Journal of Environmental Economics and Management*, 55, 248-64.

Brunnschweiler, C.N. and Bulte, E.H. (2009) Natural Resources and Violent Conflict: Resource Abundance, Dependence and Onset of Civil Wars. *Oxford Economic Papers*, 61, 651-74.

Bulte, E.H., Damania, R. and Deacon, R.T. (2005) Resource Intensity, Institutions and Development. *World Development*, 33, 1029-1044.

Burke, P. J. and Leigh, A. (2010) Do Output Contractions Trigger Democratic Change?. *American Economic Journal*, 2, 124-157.

Caselli, F., Esquivel, G. and Lefort, F. (1996) Reopenning the Convergence Debate: A New Look at Cross-Country Growth Empirics. *Journal of Economic Growth*, 1, 363-89.

Caselli, F. and Tesei, A. (2011) Resource Windfalls, Political Regimes and Political Stability. NBER Working Paper, No.17601.

Chan, S. (1987) Military Expenditures and Economic Performance. *World Military Expenditures and Arms Transfers*, US Arms Control and Disarmament Agency, US Govt Printing Office.

Clark, R. (2011) World Health Inequality: Convergence, Divergence and Development. *Journal of Social Science and Medicine*, 72, 617-624.

Collier, P. and Goderis, B. (2009) Commodity Prices, Growth and Natural Resource Curse: Reconciling a Conundrum. MPRA paper 17315, University Library of Munich, Germany.

Collier, P. and Hoeffler, A. (1998) On Economic Causes of Civil War. *Oxford Economic Papers*, 50, 563-73.

Collier, P. and Hoeffler, A. (2004) Greed and Grievance in Civil War. *Oxford Economic Papers*, 56, 563-95.

Collier, P. and Hoeffler, A. (2005) Resource Rents, Governance and Conflict. *Journal of Conflict Resolutions*, 49, 625-33.

Collier, P., Hoeffler, A., and Rohner, D. (2009) Beyond Greed and Grievance: Feasibility and Civil War. *Oxford Economic Papers*, 61, 1-27.

D'Agostino, G., Dunne, J.P. and Pieroni, L. (2012) Corruption, Military Spending and Growth. *Defense and Peace Economics*, 23 (6), 591-604.

Dal Bo, E. and Dal Bo, P. (2011) Workers, Warriors, and Criminals: Social Confict in General Equilibrium. *Journal of the European Economic Association*, 9, 646-677.

Deardorff, A. V. (1994) Growth and International Investment with Diverging Populations. *Oxford Economic Papers*, 46 (3), 477-491.

Deaton, A.S. and Miller, R.I. (1995) International Commodity Prices, Macroeconomic Performance, and Politics in Sub-Saharan Africa. *Princeton Studies in International Finance*, 79.

Dehn, J. (2000) Commodity Price Uncertainty in Developing Countries. CSAE Working Paper no. 2000-12.

DeJong, D.N. and Ripoll, M. (2006) Tariffs and Growth: An Empirical Exploration of Contingent Relationships. *The Review of Economics and Statistics* 88 (4), 625-640.

Delavallade, C. (2005) Corruption and Distribution of Public Spending in Developing Countries. *Journal of Economics and Finance* 30 (2), 222-39.

De Soysa, I. (2002) Paradise is a Bazaar? Greed, Creed and Governance In Civil War 1989-1990. *Journal of Peace Research*, 39, 395-416.

De Soysa, I. and Neumayer, E. (2007) Resource Wealth and the Risk of Civil War Onset: Results from a New Data Set of Natural Resource Rents, 1970-1999. *Conflict Management and Peace Science*, 24, 201-18.

Diamond, J. (1997) *Guns, Germs and Steel: The Fates of Human Societies*. (New York: Norton).

Dixon, J. (2009) What Causes Civil Wars? Integrating Quantitative Research Findings. *International Studies Review*, 11, 707-735.

Doces, J.A. (2011) Globalization and Population: International Trade and the Demographic Transition. *International Interactions*, 37 (2), 127-146.

Doepke, M. (2004) Accounting for Fertility Decline During the Transition to Growth. *Journal of Economic Growth*, 9, 347-383.

Dollar, D. (1992) Outward-Oriented Developing Economies Really Do Grow More Rapidly: Evidence from 95 LDCs, 1976-85. *Economic Development and Cultural Change*, 40:3, 523-544.

Dollar, D. and Kraay, A. (2002) Institutions, Trade and Growth. *Journal of Monetary Economics*, 50 (1), 133-162.

Dube, O. and Vargas, J. F. (2013) Commodity Price Shocks and Civil Conflict: Evidence from Colombia. *Review of Economic Studies*, 80, 1384-1421.

Dunne, J.P. and Tian, N. (2013) Military Expenditure, Economic Growth and Heterogeneity. *Defence and Peace Economics*, DOI: 10.1080/ 10242694.2013. 848575.

Dunne, J.P. (2012) Military Spending, Growth, Development and Conflict. *Defence and Peace Economics*, 23:6, 549-557.

Dunne, J.P. and Uye, M. (2009) Military Spending and Development. *The Global Arms Trad*e, edited by Tan Andrew. London: Europa/Routledge.

Dunne, J.P., Smith, R.P. and Willenbockel, D. (2005) Models of Military Expenditure and Growth: A Critical Review. *Defence and Peace Economics*, 16 (6), 449-61.

Dunne, J.P. (1996) Economic Effects of Military Expenditure in Developing Countries: A Survey. *Making Peace Pay*, edited by N.P. Gleditsch. Claremont, CA: Regina Books, 15.

Dunning, T. (2005) Resource Dependence, Economic Performance and Political Stability. *Journal of Conflict Resolution*, 49, 451-82.

Easterly, W. and Levine, R. (2001) It's Not Factor Accumulation: Stylized Facts and Growth Models. *World Bank Economic Review*, 15, 177-219.

Easterly, W. and Levine, R. (2003) Tropics, Germs, and Crops: The Role of Endowments in Economic Development. *Journal of Monetary Economics*, 50, 3–39.

Edwards, S. (1998) Openness, Productivity and Growth: What Do We Really Know?. *Economic Journal*, 108:447, 383-398.

Fearon, J. (2005) Primary Commodities Exports and Civil War. *Journal of Conflict Resolution*, 49, 483-507.

Fearon, J. and Laitin, D. (2003) Ethnicity, Insurgency and Civil War. *American Political Science Review*, 97, 75-90.

Findlay, R. and Kierzkowski, H. (1983) International Trade and Human Capital: A Simple General Equilibrium Model. *Journal of Political Economy*, 91, 957-978.

Francois, J. and Manchin, M. (2013) Institutions, Infrastructure and Trade. *Journal of World Development*, 46, 165-175.

Frankel, J. and Romer, D. (1999) Does Trade Cause Growth?. *American Economic Review*, 89:3, 379-399.

Gallup, J. L., Sachs, J. D. and Mellinger, A. D. (1999) Geography and Economic Development. *Journal of International Regional Science Review*, 22 (2), 179-232.

Galor, O. (2005) Unified Growth Theory: From Stagnation to Growth, in Aghion, P. and Durlauf, S. (eds.). *Handbook of Economic Growth* (Amsterdam: North-Holland), 171-293.

Galor, O. and Moav, O. (2002) Natural Selection and the Origin of Economic Growth. *Quarterly Journal of Economics*, 117, 1133-1192.

Galor, O., Moav, O. and Vollrath, D. (2006) Inequality in Land Ownership, the Emergence of Human Capital Promoting Institutions and the Great Divergence (Brown University).

Galor, O. and Mountford, A. (2006) Trade and Great Divergence: The Family Connection. *American Economic Review*, 96, 229-303.

Galor, O. and Mountford, A. (2008) Trading Population for Productivity: Theory and Evidence. *Review of Economic Studies*, Oxford University Press, 75(4), 1143-1179.

Galor, O. and Weil, D. N. (1999) From Malthusian Stagnation to Modern Growth. *American Economic Review*, 89, 150-154.

Galor, O. and Weil, D. N. (2000) Population, Technology and Growth: From the Malthusian Regime to the Demographic Transition. *American Economic Review*, 90, 806-828.

Gelb, A.H. (1988) Windfall Gains: Blessing or Curse?. New York: Oxford University Press.

Glaeser, E. L., La Porta, R., Lopez-De-Silanes, F. and Shleifer, A. (2004) Do Institutions Cause Growth?. *Journal of Economic Growth*, 9, 271-303.

Greene, W.H. (2003) Econometric Analysis. 5th Ed. Upper Saddle River, New Jersey, Prentice Hall.

Gries, T. and Grundmann, R. (2012) Trade and Fertility in the Developing World: The Impact of Trade and Trade Structure.

Grossman, H. (1991) A General Equilibrium Model of Insurrections. *American Economic Review*,81, 912-21.

Grossman, G. and Helpman, E. (1991) *Innovation and Growth in the Global Economy*, (Cambridge, MA: MIT Press).

Gupta, S., de Mello, L. and Sharan, R. (2001) Corruption and Military Spending. *European Journal of Political Economy*, 17 (4), 749-77.

Haber, S. and Menaldo, M. (2011) Do Natural Resources Fuel Authoritarianism? A Reappraisal of the Resource Curse. *American Political Science Review*, 105 (1), 1-26.

Hamid, E.A. (2012) Military Expenditures and Inequality in the Middle East and North Africa: A Panel Analysis. *Defense and Peace Economics*, 23 (6), 575-589.

Hansen, L.P. (1982) Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica* 50 (4), 1029-1054.

Harrison, A. (1996) Openness and Growth: A Time-Series, Cross-Country Analysis for Developing Countries. *Journal of Development Economics*, 48, 419-447.

Hauk, W.R. and Wacziarg, R. (2004) A Monte Carlo Study of Growth Regressions. *IMF Staff Papers*, 40 (2), 299-328.

Hirshleifer, J. (1995) Anarchy and Its Breakdown. *Journal of Political Economy*, 103, 26-52.

Homer-Dixon, T.F. (1999) Environment, Scarcity and Violence. Princeton University Press, Princeton, NJ.

Humphreys, M. (2005) Natural Resources, Conflict and Conflict Resolution: Uncovering the Mechanisms. *Journal of Conflict Resolution*, 49, 508-37.

Isham, Pritchett, J.L., Woolcock, M. and Busby, G. (2005) The Varieties of Resource Experience: Natural Resource Export Structures and the Political Economy of Economic Growth. *World Bank Economic Review*, 19, 141-174.

Jamison, D. T., Sandbu, M. and Wang, J. (2001) Cross-Country Variation in Mortality Decline, 1962-1987: The Role of Country-Specific Technical Progress. Commission on Macroeconomic and Health Working Papers, World Health Organization No. WG1:4.

Jensen, N. and Wantchekon, L. (2004) Resource Wealth and Political Regimes in Africa. *Comparative Political Studies*, 37, 816-841.

Johnson, S., Larson, W., Papageorgiu, C. and Subramanian, A. (2013) Is Newer Better? Penn World Table Revisions and Their Impact on Growth Estimates. *Journal of Monetary Economics*, 60 (2), 255-274.

Kaldor, Mary. (1999) *New and Old Wars: Organised Violence in a Global Era*. Cambridge: Polity Press.

Knight, M., Loayza, N. and Villanueva, D. (1996) The Peace Dividend: Military Spending Cuts and Economic Growth. *IMF Staff Papers*, 43, 1-44.

Krugman, P. and Venables, A. (1995) Globalization and the Inequality of Nations. *Quarterly Journal of Economics*, 90, 857-880.

Ledermann, D. and Maloney, W.F. (2007) Natural Resources, Neither Curse nor Destiny. Stanford: Stanford University Press and World Bank.

Lee, J.W. (1993) International Trade, Distortions, and Long-Run Economic Growth. *International Monetary Fund Staff Papers*, 40:2, 299-328.

Lehmijoki, U. and Palokangas, T. (2009) Population Growth Overshooting and Trade in Developing Countries. *Journal of Population Growth*, 22 (1), 43-56.

Leite, C. and Weidmann, J. (2002) Does Mother Nature Corrupt? Natural Resources, Corruption and Economic Growth. Edited by G. Abed and S. Gupta, *Governance, Corruption and Economic Performance*, International Monetary Fund, Washington, DC.

Limao, N. and Venables, A. J. (2001) Infrastructure, Geographical Disadvantage, Transport Costs and Trade. *World Bank Economic Review*, 15, 451-479.

Lucas, R. (1988) On the mechanism of economic development. *Journal of Monetary Economics,* 22:1, 3-42.

Lujala, P. (2009) The Spoils of Nature: Armed Civil Conflict and Rebel Access to Natural Resources. *Journal of Peace Research*.

Mankiw, N.G., Romer, D. and Weil, D.N. (1992) A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, 107, 407-37.

Marshal, M.G. and Jaggers, K. (2010) Polity IV Project: Dataset Users' Manual. Center for Global Policy, George Mason University.

Matsuyama, K. (1992) Agricultural Productivity, Comparative Advantage, and Economic Growth. *Journal of Economic Theory,* 58:2, 317-334.

McDermott, J. (2002) Development Dynamics: Economic Integration and the Demographic Transition. *Journal of Economic Growth,* 7, 371-410.

Mehlum, H., Moene, K., and Torvik, R. (2006) Institutions and the Resouce Curse. *Economic Journal,* 116, 1-20.

Nordas, H. K. and Piermartini, R. (2009) Infrastructure and Trade. World Trade Organization, Staff Working Paper, ERSD-2004-04.

Nunn, N. and Puga, D. (2012) Ruggedness: The Blessing of Bad Geography in Africa. *Review of Economics and Statistics* 94(1), 20-36.

Owen, A. L. and Wu, S. (2007) Is Trade Good For Your Health?. *Review of International Economics*, Wiley Blackwell, 15(4), 660-682.

Persson, T. and Tabellini, G. (2006) Democracy and Development: The Devil in Detail. *American Economic Review Papers and Proceedings*, 96 (2), 319-324.

Persson, T. and Tabellini, G. (2009) Democratic capital: The nexus of political and economic change. *American Economic Journal: Macroeconomics*, 1, 88-126.

Pritchett, L. and Summers, L. H. (1996) Wealthier is Healthier. *Journal of Human Resources*, 31(4), 841-868.

Raddatz, C. (2007) Are External Shocks Responsible for the Instability of Output in Low-Income Countries?. *Journal of Development Economics*, 84, 155-187.

Ram, Rati. (2003) Defence Expenditure and Economic Growth: Evidence from Recent Cross-Country Panel Data. *The Elgar Companion to Public Economics: Empirical Public Economics,* edited by F. Ott Attiat and J. Cebula Richard. Edward Elgar, 166-198.

Regan, A. (2003) The Bouganville Conflict: Political and Economic Agendas. Edited by K. Ballantine and J. Sherman, *The Political Economy of Armed Conflict: Beyond Greed and Grievance*, Lynne Riener, London.

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. (2001) Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence. *NBER Macroeconomics Annual 2000*, MIT Press, 15, 261-338.

Rodrik, D., Subraminian, A. and Trebbi, F. (2004) Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development. *Journal of Economic Growth*, 9, 131-165.

Ron, J. (2005) Paradigm in Distress: Primary Commodities and Civil War. *Journal of Conflict Resolution*, 49, 443-50.

Roodman, D. (2006) How to do xtabond2: An Introduction to "Difference" and "System" GMM in STATA. *Center for Global Development*, Working paper no. 103.

Roodman, D. (2009) A Note on the Theme of Too Many Instruments. *Oxford Bulletin of Economics and Statistics*, 71 (1), 135-158.

Ross, M.L. (1999) The Political Economy of the Resource Curse. *World Politics*, 51, 297-322.

Ross, M.L. (2001) Does Oil Hinder Democracy?. *World Politics*, 53, 325-361.

Ross, M.L. (2004a) What Do We Really Know About Natural Resources and Civil War?. *Journal of Peace Research*, 41, 337-56.

Ross, M.L. (2004b) How Do Natural Resources Influence Civil War? Evidence from 13 Cases. *International Organisations*, 58, 35-68.

Ross, M.L. (2006) A Closer Look at Oil, Diamond and Civil War. *Annual Review of Political Science*, 9, 265-300.

Rosser, A (2006) The Political Economy of the Resource Curse: A Literature Survey. IDS Working Paper 268, Institute of Development Studies, Brighton.

Sachs, J.D. and Warner, A.M. (1995) Economic Reform and the Process of Global Integration. *Brooking Papers on Economic Activity*, 1, 1-118.

Sachs, J.D. and Warner, A.M. (1995) Natural Resource Abundance and Economic Growth. NBER Working Paper No. 5398.

Sachs, J.D. and Warner, A.M. (1999) The Big Push, Natural Resource Booms and Growth. *Journal of Development Economics*, 59, 43-76.

Sachs, J.D. and Warner, A.M. (2001) The Curse of Natural Resources. *European Economic Review*, 45, 827-838.

Sala-i-Martin, X. and Subramanian, A. (2013) Addressing the Natural Resource Curse: An Illustration from Nigeria. *Journal of African Economies*, Centre for the Study of African Economies (CSAE), 22 (4), 570-615.

Saure, P. and Zoabi, H. (2011) International Trade, the Gender Gap, Fertility and Growth.

Savun, B. and Cook, S. (2011) Exogenous Shocks, Bargaining Problems, and the Onset of Civil War. American Political Science Association Annual Meeting.

Sirimaneetham, V. and Temple, J.R.W. (2009) Macroeconomic Stability and the Distribution of Growth Rates. *World Bank Economic Review,* 23 (3), 443-479.

Smaldone, J.P. (2006) African Military Spending: Defense Versus Development?. *African Security Review*, 15(4), 18-32.

Smith, Ron. (2000a) Defence Expenditure and Economic Growth. *Making Peace Pay,* edited by N.P. Gleditsch, G. Lindgren, N. Mouhleb and S. Smit. Claremount, CA: Regina Books, 15.

Smith, Ron. (2000b) Defence Expenditure and Economic Growth. *Making Peace Pay: A Bibliography on Disarmament and Conversion*, edited by N.P. Gleditsch, G. Lindgren, N. Mouhleb and S. Smit and Indra De Soysa. Claremount, CA: Regina Books, 15-24.

Snyder, R. and Bhavnani, R. (2005) Diamonds, Blood and Taxes: A Revenue-Centered Framework For Explaining Social Order. *Journal of Conflict Resolution,* 49, 563-97.

Stokey, N. L. (1991) The Volume and Composition of Trade Between Rich and Poor Countries. *Review of Economic Studies*, 58, 63-80.

Torvik, R. (2002) Natural Resources, Rent Seeking and Welfare. *Journal of Development Economics*, 67, 455-470.

Van der Ploeg, F. (2009) Challenges and Opportunities For Resource Rich Economies. *Journal of Economic Literature*.

Vreeland, J.P. (2008) The Effect of Political Regime on Civil War: Unpacking Anocracy. *Journal of Conflict Resolution*, 52(3), 401-425.

Wacziarg, R. (2001) Measuring the Dynamic Gains from Trade. *World Bank Economic Review*, 15 (3), 393-429.

Wilson, J. S., Mann, C. L. and Otsuki, T. (2005) Assessing the Benefits of Trade Facilitation: A Global Perspective. *The World Economy*, 28 (6), 841-871.

Windmeijer, F. (2005) A Finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, 126 -1.

Young, A. (1991) Learning by Doing and the Dynamic Effects of International Trade. *Quarterly Journal of Economics*, 106, 369-405.

APPENDICES

Appendix 2-A: Generalized Method of Moments (GMM)

Letting the subscripts i and t represent country and time period respectively, the general equational form of growth regressions can be written as

$$y_{it} - y_{i(t-1)} = \alpha\, y_{i(t-1)} + \delta'\, p_{it} + \varphi'\, d_{it} + \mu_t + \xi_i + \varepsilon_{it} \qquad \text{(2A1)}$$

where y is the log of per capita income, p_{it} and d_{it} are the vectors of predetermined and potentially endogenous regressors, respectively; μ_t is a period-specific constant, ξ_i is an unobserved country-specific effect, and ε_{it} is an error term. Equation (2A1) then can be rewritten as

$$y_{it} = (1+\alpha)\, y_{i(t-1)} + \delta'\, p_{it} + \varphi'\, d_{it} + \mu_t + \xi_i + \varepsilon_{it} \qquad \text{(2A2)}$$

which makes apparent that the estimation of (2A1) is analogous to the estimation of a dynamic equation with a lagged-dependent variable on the right-hand side. As discussed in Caselli *et al.* (1996), the consistency of OLS estimators depends on the assumption that the country-specific effect ξ_i is orthogonal to other right-hand side variables. This assumption in growth regressions is clearly violated due to the presence of lagged income as an explanatory variable: i.e. $E[y_{i(t-1)}\xi_i] \neq 0$. Thus, a first step to achieve consistent estimates starts by eliminating the country-specific term.

In order to achieve consistency, several approaches, such as eliminating the country-specific term either by taking deviations from period averages (fixed effects estimator) or implementation of a country-specific random variable (seemingly unrelated regression estimator) and others are applied. These strategies deal successfully with estimation inconsistencies only if explanatory variables are strictly exogenous.

Alternative GMM-based approaches are derived by taking the first differences of (2A2), which yields

$$y_{it} - y_{i(t-1)} = (1+\alpha)\,(y_{i(t-1)} - y_{i(t-2)}) + \delta'(p_{it} - p_{i(t-1)}) + \varphi'(d_{it} - d_{i(t-1)}) + (\mu_t - \mu_{t-1}) + (\varepsilon_{it} - \varepsilon_{i(t-1)}) \qquad \text{(2A3)}$$

Least squares procedures cannot be used to estimate (2A3) because by construction $y_{i(t-1)} - y_{i(t-2)}$ is correlated with $\varepsilon_{it} - \varepsilon_{i(t-1)}$. Moreover, one would like to deal with likely endogeneity of all the explanatory variables.

To deal with inconsistency and likely endogeneity issues, Arellano and Bond (1991) proposed the GMM Difference estimator that uses lagged levels of the explanatory variables as instruments in the estimation of (2A3). The estimator is based on the following identifying assumptions:

$$E\,[\varepsilon_{it}\,\varepsilon_{i(t-j)}] = 0 \text{ for all } j \neq 0 \quad (2A4)$$

$$E\,[\mu_t\,\varepsilon_{i(t+s)}] = 0 \text{ for all } t\text{; and } s \geq 0 \quad (2A5)$$

$$E\,[y_{i(t-1)}\,\varepsilon_{i(t+s)}] = 0 \text{ for all } t\text{; and } s \geq 0 \quad (2A6)$$

$$E\,[p_{i(t-1)}\,\varepsilon_{i(t+s)}] = 0 \text{ for all } t\text{; and } s \geq 0 \quad (2A7)$$

$$E\,[d_{i(t-2)}\,\varepsilon_{i(t+s)}] = 0 \text{ for all } t\text{; and } s \geq 0 \quad (2A8)$$

where (2A4) implies that the error term ε_{it} is not serially correlated; (2A5) entails that the period specific constant μ_t is strictly exogenous; and as indicated by (2A6), (2A7) and (2A8), both the predetermined explanatory variables $y_{i(t-1)}$ and $p_{i(t-1)},$ and $d_{i(t-2)}$ are weakly exogenous, i.e. past realizations of variables are uncorrelated with current and future shocks. Under these assumptions, lagged levels of the explanatory variables can be used as instruments as specified by the following moment conditions:

$$E\,[\mu_{t-s}\,(\varepsilon_{it} - \varepsilon_{i(t-1)}] = 0 \text{ for } s \geq 0,\ t = 3,\ \ldots,\ T \quad (2A9)$$

$$E\,[y_{i(t-s)}\,(\varepsilon_{it} - \varepsilon_{i(t-1)})] = 0 \text{ for } s \geq 2,\ t = 3,\ \ldots,\ T \quad (2A10)$$

$$E\,[p_{i(t-s)}\,(\varepsilon_{it} - \varepsilon_{i(t-1)})] = 0 \text{ for } s \geq 2,\ t = 3,\ \ldots,\ T \quad (2A11)$$

$$E\,[d_{i(t-s)}\,(\varepsilon_{it} - \varepsilon_{i(t-1)})] = 0 \text{ for } s \geq 3,\ t = 3,\ \ldots,\ T \quad (2A12)$$

As discussed in Easterly and Levine (2001), the GMM Difference estimator has the statistical shortcoming that if the regressors in (2A3) are persistent, then lagged levels of *y*, *p* and *d* may be weak instruments, and so the estimated coefficients may be biased. Further, taking differences of the original level equation (2A2) reduces the time dimension of the sample and leaves information about the level relationship between explanatory variables and growth unused.

To overcome the concerns induced by taking first-differences, Arellano and Bover (1995) and Blundell and Bond (1998) developed the System GMM estimator that combines the differenced model (2A3) with the levels model (2A2). In order to be able to use lagged differences of the variables on the right-hand side of (2A2) as valid instruments for the regression in levels, the following identifying assumptions are introduced:

$$E\ [\xi_i\ (y_{it} - y_{i(t-1)})] = 0 \text{ for all } t \tag{2A13}$$

$$E\ [\xi_i\ (p_{it} - p_{i(t-1)})] = 0 \text{ for all } t \tag{2A14}$$

$$E\ [\xi_i\ (d_{it} - d_{i(t-1)})] = 0 \text{ for all } t \tag{2A15}$$

$$E\ [\xi_i\ (\mu_t - \mu_{t-1})] = 0 \text{ for all } t \tag{2A16}$$

which imply that there is no correlation between the differences of the regressors and the country-specific effect, i.e. interactions between the country-specific effect and the regressors are stationary. Given (2A13) - (2A16), the following moment conditions can be added to those specified above in (2A9) - (2A12):

$$E\ [(\xi_i + \varepsilon_{it})(\mu_{t-s} - \mu_{t-s-1})] = 0 \text{ for } s = 0 \tag{2A17}$$

$$E\ [(\xi_i + \varepsilon_{it})(y_{i(t-1-s)} - y_{i(t-2-s)})] = 0 \text{ for } s = 1 \tag{2A18}$$

$$E\ [(\xi_i + \varepsilon_{it})(p_{i(t-s)} - p_{i(t-1-s)})] = 0 \text{ for } s = 1 \tag{2A19}$$

$$E\ [(\xi_i + \varepsilon_{it})(d_{i(t-s)} - d_{i(t-1-s)})] = 0 \text{ for } s = 2 \tag{2A20}$$

By avoiding inconsistency problems associated with OLS estimators, and weak-instrument problems associated with the GMM Difference estimator, the System GMM estimator seems particularly attractive in this context. However it is of emphasis that the move from the difference to the system GMM estimator also involves a cost: the adoption of the additional assumptions regarding stationarity implicit in (2A13) - (2A16), which are difficult to justify *a priori*.

Additional concern regarding employing GMM estimators raised in the literature is the effect of instrument proliferation, i.e. a large collection of instruments, even if individually valid, can be collectively invalid in finite samples because they overfit endogenous variables. This might weaken the Hansen test of overidentifying restrictions for the joint validity of moment conditions, which is commonly relied upon to check instrument proliferation. To ensure that the estimated effect during the analysis is not driven by the number of instruments, investigation under the GMM estimators employs the “1 lag restriction” technique followed by Roodman (2009) that uses only certain lags instead of all available lags as instruments.

It is also of note that GMM estimators are designed for situations with “small T and large N” panels, implying few time periods and many individuals; and hence employing small samples during the investigation (especially when the analysis stratifies the data set into separate subsamples) can also weaken the Hansen test yielding high p-value statistics (e.g., in excess of 0.90). Therefore, the results from these specifications must be read with caution since high p-values can be a warning signal that too many moment restrictions are in use.

Furthermore, Roodman (2006) shows how the design of each regressor according to their exogeneity levels during the treatment process might alter the estimated results of interest. To overcome these concerns, the analysis applies upper and lower bound conditions for treatment of each regressor. In particular, these bounds are achieved by performing OLS and Least Squares Dummy Variables (LSDV or Fixed effects) estimation which provides the values where good estimates of the true parameter should lie in or near the range of these values. Then each regressor is treated either as predetermined or endogenous during the GMM analysis depending on which treatment approach delivers superior estimate that lies within or the closest to this range.

Appendix 2-B: List of Countries

Code	Country	Code	Country	Code	Country
1	Argentina$_g$	25	Iran$_i$	49	Romania$_g$
2	Australia	26	Ireland	50	Rwanda$_i$
3	Austria	27	Israel	51	Senegal$_{gi}$
4	Belgium	28	Italy	52	Sierra Leone
5	Botswana$_i$	29	Japan$_i$	53	Singapore$_s$
6	Brazil$_s$	30	Jordan$_g$	54	South Africa$_i$
7	Cameroon	31	Kenya	55	Spain
8	Canada$_i$	32	Korea Rep.	56	Sri Lanka$_i$
9	Colombia	33	Malaysia	57	Sweden$_i$
10	Congo Dem. Rep.$_{gi}$	34	Mauritius	58	Switzerland$_i$
11	Costa Rica	35	Mexico	59	Syria$_i$
12	Cote d`Ivoire$_g$	36	Morocco$_g$	60	Thailand
13	Denmark	37	Nepal$_i$	61	Togo$_{gi}$
14	Ecuador$_i$	38	Netherlands	62	Trinidad and Tobago$_g$
15	Egypt	39	New Zealand	63	Tunisia
16	Fiji	40	Nicaragua	64	Turkey$_i$
17	Finland	41	Norway	65	United Kingdom
18	France$_i$	42	Pakistan	66	United States$_i$
19	Ghana$_i$	43	Panama$_{gi}$	67	Uruguay$_i$
20	Greece	44	Papua New Guinea	68	Venezuela
21	Hungary	45	Paraguay$_i$	69	Zambia$_i$
22	Iceland	46	Peru	70	Zimbabwe$_i$
23	India	47	Philippines$_i$		
24	Indonesia	48	Portugal$_i$		

Note: Subscripts *g*, *s* and *i* represent countries, respectively, those are excluded from the analysis of tariffs relationship with growth, schooling and infrastructure.

Appendix 2-C: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP p.c. (log)	420	8.83	1.02	5.74	10.64
Tariff rates (%)	374	9.79	8.65	0	48.28
Fertility rate (log)	420	1.19	0.53	0.17	2.14
Life expectancy (log)	420	4.17	0.17	3.16	4.39
Infant mortality (log)	420	3.42	1.04	1.25	5.31
Real investment ratio (%)	420	22.03	9.79	1.00	56.69
Real government expenditure ratio (%)	420	16.78	7.17	5.59	61.55
Years of sec. sch.(male)	420	1.99	1.20	0.13	5.36
Years of sec. sch. (female)	420	1.80	1.24	0.06	5.36
Male Prim. Sch.-Enrolment Ratio (%)	363	95.29	10.13	47.24	100
Female Prim. Sch.-Enrolment Ratio (%)	363	90.16	17.49	16.21	100
Paved roads (% total roads)	132	56.74	33.47	3.2	100

Note: All descriptive statistics are based on panel country averages for the period of 1975-2000 and 70 countries sample, except the last three. Summary of school-enrolment ratio by gender is restricted to the 68 countries sample. Respective statistics of paved roads are summarized for 44 countries data set over the period of 1990-2000.

Appendix 2-D: Sample Correlations

Panel A: 70 countries sample (1975-2000)					
	GDP per capita	Tariff rates	Fertility rate	Life Expectancy	Infant Mortality
GDP per capita	1				
Tariff rates	-0.67	1			
Fertility rate	-0.77	0.70	1		
Life Expectancy	0.79	-0.68	-0.88	1	
Infant Mortality	-0.73	0.70	0.87	-0.96	1

Panel A: 68 countries sample (1975-2000)				
	GDP per capita	Tariff rates	Primary sch. enr. (male)	Primary sch. enr. (female)
GDP per capita	1			
Tariff rates	-0.69	1		
Primary sch. enr. (male)	0.33	-0.38	1	
Primary sch. enr. (female)	0.47	-0.55	0.82	1

Panel C: 44 countries sample (1990-2000)			
	GDP per capita	Tariff rates	Paved roads
GDP per capita	1		
Tariff rates	-0.73	1	
Paved roads	0.61	-0.52	1

Appendix 3-A: List of Countries

Country	Income Rank, 1970	Income Rank, 2005	Country	Income Rank, 1970	Income Rank, 2005	Country	Income Rank, 1970	Income Rank, 2005
Algeria	2	3	Greece	4	4	Pakistan	1	1
Argentina	3	3	Guatemala	2	3	Panama	2	3
Australia	4	4	Guyana	1	2	Papua New Guinea	1	1
Austria	4	4	Honduras	1	2	Paraguay	1	2
Bangladesh	1	1	Hungary	3	4	Peru	2	3
Belgium	4	4	India	1	1	Philippines	1	1
Bolivia	2	2	Indonesia	1	2	Portugal	3	4
Botswana	1	3	Iran	3	3	Rwanda	1	1
Brazil	2	3	Ireland	3	4	Senegal	1	1
Burundi	1	1	Israel	4	4	Sierra Leone	1	1
Cameroon	1	1	Italy	4	4	Singapore	3	4
Canada	4	4	Jamaica	3	3	South Africa	2	3
Central Afr. Rep.	1	1	Jordan	2	2	Spain	4	4
Chile	2	3	Kenya	1	1	Sri Lanka	1	2
China	1	2	Korea, Rep.	2	4	Sudan	1	1
Colombia	2	3	Liberia	1	1	Sweden	4	4
Congo, Dem.	1	1	Malawi	1	1	Switzerland	4	4
Congo, Rep.	1	1	Malaysia	1	3	Syria	1	2
Costa Rica	3	3	Mali	1	1	Thailand	1	3
Cote d'Ivoire	1	1	Mauritania	1	1	Togo	1	1
Cyprus	3	4	Mauritius	1	3	Tunisia	1	2
Ecuador	2	3	Mexico	3	4	Turkey	2	3
Egypt	1	2	Morocco	1	2	Uganda	1	1
El Salvador	2	3	Mozambique	1	1	United Kingdom	4	4
Fiji	1	2	Nepal	1	1	United States	4	4
Finland	4	4	Netherlands	4	4	Uruguay	2	3
France	4	4	New Zealand	4	4	Venezuela	3	3
Gambia	1	1	Nicaragua	2	1	Zambia	1	1
Germany	4	4	Niger	1	1	Zimbabwe	1	1
Ghana	1	1	Norway	4	4			

Appendix 3-B: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP p.c. (log)	801	8.32	1.33	4.77	10.82
GDP per capita growth rate	796	0.02	0.03	-0.36	0.19
Military Expenditure over GDP	778	0.028	0.028	0	0.29
Population Growth rate	801	0.07	0.01	0.01	0.14
Real Investment ratio	801	0.23	0.09	0.04	0.72
Life Expectancy (log)	801	4.13	0.19	3.16	4.40
Schooling (log)	801	1.61	0.67	-1.24	2.57
Openness (log)	801	3.99	0.62	2.21	6.06

Note: All descriptive statistics are based on panel country averages for the period of 1970-2010 and 89 countries sample.

Appendix 4-A: Robustness Checks for Threat Levels Analysis

Beyond the robustness checks described in Tables 4-2 and 4-A1 for the analysis conditional on threat levels, special attention is paid to the potential influence on the results of several subsets of countries. The collection of these subsets features countries singled out due to the maintenance of high shares of military expenditure and on the basis of certain unusual aspects of their conflict experiences during the time period spanned by the sample. Results of this exercise are reported in Tables 4-A2 and 4-A3 for four subsets of countries: (i) high military expenditure share countries, specified as those which spend more than approximately one standard deviation from the mean in military sector; (ii) countries with high level of threat, defined as those experienced threat more than approximately three standard deviations from the mean of cumulative conflict incidence; (iii) the poorest countries with high military expenditure shares and high levels of threat, stipulated as those are in the bottom of income distribution, which spend more than average in the military sector and experienced an external threat above the mean of cumulative conflict incidence;[113] and (iv) the union of these subsets. For each subset, Table 4-A2 and 4-A3 report the list of countries, the cumulative number of threat incidences during the time period spanned by the sample, their average military expenditure shares and growth rates measured over the entire sample period, and the coefficient estimates obtained for the interaction of military spending with threat given their removal from the sample in addition to outlier countries. For ease of comparison, the estimates obtained given the exclusion of the outlier countries, are also reported.

The coefficient estimates of the interaction term with internal and external threat incidence change very little given the removal of any one of the subsets under consideration; and generally, enter significantly at conventional levels. For both cases, the estimates obtained given the removal of each subsample lie within approximately one standard deviation of the estimate when the potential outliers are removed. Statistical significance in the case when military expenditure is interacted with internal conflict onset also changes very little, indicating strong qualitative

[113] The cut-off level for countries in the bottom of income distribution is taken as in DeJong and Ripoll (2006), where country classifications are obtained by mapping classification thresholds as defined by the World Bank's income measures into the corresponding Penn World income measures. The resulting definition is specified as those with real per capita GDP level less than $2,650.

effects. What does change somewhat is the magnitude of the coefficient estimates of the interaction term when the third and the fourth subsets are excluded. The significance of the coefficient estimates of the interaction term with war intensity also exhibits sensitivity to the exclusion of particular subsets, with the magnitude of estimates lying within approximately two standard deviations of the estimate given the exclusion of potential outliers.

Overall, these findings suggest that the negative and significant relationship is only apparent among countries facing low threats, while in the presence of sufficiently high threats military expenditure is not materially detrimental for growth.

Table 4-A1
Military Expenditure and External Threat
Dependent Variable: Log difference of real GDP per capita (Laspeyres)

	External threat: War intensity			**External Threat Incidence**
	Main Model (1)	**Outliers Removed** (2)	**Alternative Model** (3)	(4)
Initial GDP p.c. (log)	-0.006***	-0.006***	-0.006***	-0.023***
	(0.002)	(0.002)	(0.002)	(0.004)
Mil. exp/GDP	**-0.003*** **	**-0.004*** **		**-0.006*** **
	(0.001)	**(0.001)**		**(0.001)**
Mil*Threat	**0.008***	**0.026****		**0.0025***
	(0.004)	**(0.011)**		**(0.0014)**
Mil*High Threat			**-0.001**	
			(0.001)	
Mil*Low Threat			**-0.003*** **	
			(0.001)	
Threat	0.019	-0.062	0.016	-0.013**
	(0.045)	(0.064)	(0.041)	(0.006)
Pop. growth (log)	-0.001	-0.004	-0.001	0.015*
	(0.007)	(0.007)	(0.0067)	(0.008)
Life expectancy (log)	0.088***	0.088***	0.087***	0.044**
	(0.012)	(0.013)	(0.013)	(0.022)
Investment/GDP	0.111***	0.097***	0.099***	0.156***
	(0.013)	(0.013)	(0.013)	(0.021)
Openness (log)	-0.007***	-0.010***	-0.009***	-0.013***
	(0.002)	(0.002)	(0.002)	(0.004)
Schooling (log)	-0.006*	-0.005	-0.006	-0.009
	(0.004)	(0.004)	(0.004)	(0.009)
Countries/Observations	89/695	85/665	85/665	83/649
Threshold Analysis				
Threat	0.376	0.144		2.23
	(0.064)	(0.006)		(2.74)

Note: Columns 1 estimates military expenditure and economic growth relationship conditional on war intensity levels, while column 2 runs the same exercise excluding the potential outlier countries. Column 3 applies the alternative approach to estimate the impact of military expenditure for countries with different threat levels by interacting military expenditure with two separate dummy variables: one for countries facing low threats, and the other for countries with high threat levels where the average threshold value of 0.260 ((0.376+0.144)/2) is used for the analysis. Column 4 employs an alternative external threat incidence measure constructed using UCDP/PRIO data. The analysis of military expenditure and growth relationship conditional on external threat levels using GMM estimator demonstrates marginally insignificant impact for the interaction terms. Therefore column 4 reports Fixed effect estimates for the analysis of non-linear relationship conditional on external threat incidence following the majority of research analyses in the defence literature. Since the external threat measure of war intensity by construction is constant over time within a country, and thus is dropped when FE estimator is used, columns 1-3 employ seemingly unrelated regressions (SUR) estimator instead of FE for the analysis of non-linear relationship conditional on war intensity levels. All specifications control for time fixed effects. Eliminated countries in column 2 are Botswana, China, Israel, and Singapore; in column 3 are Botswana, China, Egypt, and Singapore; and in column 4 are Botswana, China, Egypt, Israel, Korea Rep. and Singapore. The outliers are singled out using OLS regressions. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Standard errors are presented in parentheses.

Table 4-A2
Exclusion of Countries with Unusual Characteristics
Dependent Variable: Log difference of real GDP per capita (Laspeyres)
Estimation: System GMM estimation with Windmeijer (2005) Small Sample Robust Correction

Country	No. of Internal Threat Incidence	Average Mil. Exp. Share	Average Growth Rate	Coeff.	S. E.	p value
Remove Outliers						
Botswana	0	3.32	5.75			
China	0	1.73	6.90		**Mil*Threat (Onset)**	
Egypt	6	8.66	3.04	0.251	0.141	0.078
Israel	45	14.96	2.42		**Mil*Threat (Incidence)**	
Korea Rep.	0	3.85	5.47	0.0019	0.0009	0.043
Mali	5	2.19	1.79			
Singapore	0	4.61	5.27			
Remove High Military Exp. Share Countries						
Egypt	6	8.66	3.04		**Mil*Threat (Onset)**	
Israel	45	14.96	2.42	0.351	0.147	0.020
Jordan	0	11.25	-0.02		**Mil*Threat (Incidence)**	
Syria	5	9.05	1.48	0.0029	0.0009	0.002
United States	9	5.37	1.68			
Remove High Internal Threat Level Countries						
Colombia	45	2.31	2.39		**Mil*Threat (Onset)**	
				0.252	0.139	0.075
Israel	45	14.96	2.42		**Mil*Threat (Incidence)**	
				0.0018	0.0009	0.052
Philippines	42	1.66	1.51			
Remove Poorest Countries with High Military Exp. Shares and High Internal Threat Levels						
					Mil*Threat (Onset)	
Mozambique	16	4.76	1.21	0.493	0.207	0.019
					Mil*Threat (Incidence)	
Pakistan	15	4.99	2.34	0.0023	0.0011	0.060
Remove All Subsets						
Colombia	45	2.31	2.39			
Egypt	6	8.66	3.04			
Israel	45	14.96	2.42		**Mil*Threat (Onset)**	
Jordan	0	11.25	-0.02	0.603	0.195	0.003
Mozambique	16	4.76	1.21		**Mil*Threat (Incidence)**	
Pakistan	15	4.99	2.34	0.0032	0.0013	0.012
Philippines	42	1.66	1.51			
Syria	5	9.05	1.48			
United States	9	5.37	1.68			

Note: In addition to variables of interest reported above, all specifications control for log of initial income, internal threat (either onset or incidence measure), log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. High military expenditure share countries are specified as those which spend more than 1 standard deviation from the mean in military sector. High internal threat level countries are specified as those experienced internal threat more than 3 standard deviations from the mean of cumulative internal conflict incidence. The poorest countries with high military expenditure shares and high external threat levels are specified as those are in the bottom of income distribution (income rank 1) which spend more than 1 standard deviation from the mean in military sector and experienced internal threat above the mean of cumulative internal conflict incidence. The estimation results are achieved using the "1 lag restriction" technique following Roodman (2009). The number of countries/observations for the military spending and internal conflict onset (incidence) interaction analysis in each panel is, respectively, 82/478 (82/642), 79/460 (79/618), 80/466 (80/626), 80/467 (80/626) and 75/437 (75/587). The time span for the military spending and internal conflict onset interaction analysis is based on balanced dataset for the 1970-2000 period (T=6), while the investigation for the incidence analysis is for the 1970-2010 period (T=8).

Table 4-A3

Exclusion of Countries with Unusual Characteristics

Dependent Variable: Log difference of real GDP per capita (Laspeyres)

Estimation: Fixed Effects Estimator

Country	No. of External Threat Incidence	Average Mil. Exp. Share	Average Growth Rate	Coeff.	S. E.	p value
Remove Outliers						
Botswana	0	3.32	5.75			
China	12	1.73	6.90		**Mil*Threat (Intensity)**	
Egypt	4	8.66	3.04	0.047	0.015	0.002
Israel	4	14.96	2.42		**Mil*Threat (Incidence)**	
Korea Rep.	0	3.85	5.47	0.0025	0.0014	0.078
Singapore	0	4.61	5.27			
Remove High Military Exp. Share Countries						
Egypt	4	8.66	3.04			
Israel	4	14.96	2.42		**Mil*Threat (Intensity)**	
Jordan	1	11.25	-0.02	0.011	0.019	0.596
Syria	2	9.05	1.48		**Mil*Threat (Incidence)**	
United States	3	5.37	1.68	0.0027	0.0015	0.071
Remove High External Threat Level Countries						
China	12	1.73	6.90		**Mil*Threat (Intensity)**	
India	16	2.97	3.48	0.084	0.019	0.000
Iran	10	4.69	0.89		**Mil*Threat (Incidence)**	
Pakistan	15	4.99	2.34	0.0036	0.0019	0.067
Remove Poorest Countries with High Military Exp. Shares and High External Threat Levels						
Egypt	4	8.66	3.04		**Mil*Threat (Intensity)**	
India	16	2.97	3.48	0.035	0.017	0.043
Pakistan	15	4.99	2.34		**Mil*Threat (Incidence)**	
Syria	2	9.05	1.48	0.0035	0.0018	0.050
Remove All Subsets						
China	12	1.73	6.90			
Egypt	4	8.66	3.04			
India	16	2.97	3.48		**Mil*Threat (Intensity)**	
Iran	10	4.69	0.89	0.075	0.136	0.579
Israel	4	14.96	2.42		**Mil*Threat (Incidence)**	
Jordan	1	11.25	-0.02	0.0035	0.0022	0.113
Pakistan	15	4.99	2.34			
Syria	2	9.05	1.48			
United States	3	5.37	1.68			

Note: In addition to variables of interest reported above, all specifications control for log of initial income, external threat (either intensity or incidence measure), log of population growth, log of life expectancy, investment ratio, log of openness and schooling, and time fixed effects. High military expenditure share countries are specified as those which spend more than 1 standard deviation from the mean in military sector. High external threat level countries are specified as those experienced external threat more than 3 standard deviations from the mean of cumulative external conflict incidence. The poorest countries with high military expenditure shares and high external threat levels are specified as those are in the bottom of income distribution (income rank 1) which spend more than average in military sector and experienced external threat above the mean of cumulative external conflict incidence. The number of countries/observations for each panel is, respectively, 83/649, 80/625, 80/625, 80/625 and 77/601. The time span for the analysis is based on balanced dataset for the 1970-2010 period (T=8).

Appendix 4-B: List of Countries

Code	Country	Code	Country	Code	Country
1	Algeria	31	Greece	61	Pakistan
2	Argentina	32	Guatemala	62	Panama
3	Australia	33	Guyana	63	Papua New Guinea
4	Austria	34	Honduras	64	Paraguay
5	Bangladesh	35	Hungary	65	Peru
6	Belgium	36	India	66	Philippines
7	Bolivia	37	Indonesia	67	Portugal
8	Botswana	38	Iran	68	Rwanda $_c$
9	Brazil	39	Ireland	69	Senegal
10	Burundi $_c$	40	Israel	70	Sierra Leone
11	Cameroon	41	Italy	71	Singapore
12	Canada	42	Jamaica	72	South Africa
13	Central African Rep. $_c$	43	Jordan	73	Spain
14	Chile	44	Kenya	74	Sri Lanka
15	China	45	Korea, Rep. of	75	Sudan
16	Colombia	46	Liberia	76	Sweden
17	Congo, Dem. Rep.	47	Malawi	77	Switzerland
18	Congo, Rep. of	48	Malaysia	78	Syria
19	Costa Rica	49	Mali	79	Thailand
20	Cote d'Ivoire	50	Mauritania $_c$	80	Togo
21	Cyprus	51	Mauritius $_c$	81	Tunisia
22	Ecuador	52	Mexico	82	Turkey
23	Egypt	53	Morocco	83	Uganda
24	El Salvador	54	Mozambique	84	United Kingdom
25	Fiji $_c$	55	Nepal $_c$	85	United States
26	Finland	56	Netherlands	86	Uruguay
27	France	57	New Zealand	87	Venezuela
28	Gambia	58	Nicaragua	88	Zambia
29	Germany	59	Niger	89	Zimbabwe
30	Ghana	60	Norway		

Note: Subscripts c represent countries those are excluded from the analysis when the corruption variable is employed.

Appendix 4-C: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP p.c. (log)	801	8.32	1.33	4.77	10.82
GDP per capita growth rate	796	0.02	0.03	-0.36	0.19
Military Expenditure over GDP (%)	778	2.81	2.81	0	28.62
Natural Resource Rents	797	0.04	0.08	0	0.64
Energy Resource Rents	797	0.03	0.08	0	0.64
Oil Rents	667	0.03	0.07	0	0.64
Population Growth rate	801	0.07	0.01	0.01	0.14
Real Investment ratio	801	0.23	0.09	0.04	0.72
Life Expectancy (log)	801	4.13	0.19	3.16	4.40
Schooling (log)	801	1.61	0.67	-1.24	2.57
Openness (log)	801	3.99	0.62	2.21	6.06
War Intensity	799	0.01	0.04	0	0.29
External Conflict Incidence	801	0.12	0.56	0	5
Internal Conflict Incidence	801	0.93	1.75	0	5
Cumulative Incidence of Ext. Conflict	801	1.11	2.99	0	16
Cumulative Incidence of Int. Conflict	801	8.38	11.83	0	45
Dist. to major navigable river (10^3 km)	783	1.55	1.33	0.001	9.1
Soil	801	0.37	0.21	0	0.98
Tropical	801	0.43	0.45	0	1.00
Democracy	799	4.84	4.29	0	10
Polity2	799	2.58	7.15	-10	10
Probability of civil conflict onset	618	0.013	0.032	0	0.327
Corruption	491	3.16	1.40	0	6

Note: Descriptive statistics are based on panel country averages for the period of 1970-2010 and a sample of 89 countries, except the last two. Summary of civil conflict onset probability is restricted to the period of 1970-2000. Respective statistics of corruption are summarized for 82 countries data set over the period of 1985-2010.

Table 5-A1
Long and Short-Run Impact of Commodity Price Index
Dependent Variable: Log difference of real GDP per capita (Laspeyres)

	(1)	(2)	(3)
	Estimates of Long-Run Coefficients		
Trade openness $_{t-1}$	0.027***	0.026***	0.027***
	(0.006)	(0.006)	(0.008)
Inflation (log) $_{t-1}$	-0.025***	-0.024***	-0.023**
	(0.009)	(0.009)	(0.010)
Reserves/GDP ratio $_{t-1}$	0.066**	0.063*	0.049
	(0.033)	(0.034)	(0.041)
Commodity export price index $_{t-1}$	**-0.085*** **		
	(0.027)		
Points export price index $_{t-1}$		**-0.086*** **	
		(0.029)	
Diffuse export price index $_{t-1}$		**0.136**	
		(0.379)	
Energy export price index $_{t-1}$			**-0.187*** **
			(0.057)
Non-energy export price index $_{t-1}$			**0.301** **
			(0.116)
	Estimates of Short-Run Coefficients		
GDP per capita (log)$_{t-1}$	-0.047***	-0.046***	-0.045***
	(0.006)	(0.006)	(0.008)
Δ GDP per capita (log)$_{t-1}$	0.089**	0.103***	0.135**
	(0.034)	(0.037)	(0.053)
Δ Trade openness $_{t-1}$	-0.005	-0.006	-0.013
	(0.015)	(0.015)	(0.017)
Δ Inflation (log) $_{t-1}$	0.004	0.004	0.005
	(0.006)	(0.006)	(0.006)
Δ Reserves/GDP ratio $_{t-1}$	0.171**	0.173**	0.176
	(0.079)	(0.079)	(0.140)
Δ Commodity export price index $_{t}$	0.342**	0.336**	0.356**
	(0.155)	(0.158)	(0.153)
Δ Commodity export price index $_{t-1}$	0.311***	0.314***	0.335***
	(0.104)	(0.103)	(0.114)
Δ Commodity export price index $_{t-2}$	0.424***	0.413***	0.505***
	(0.152)	(0.153)	(0.163)
Country FE	YES	YES	YES
Time FE	YES	YES	YES
Countries/Observations	135/4200	126/4041	70/2225
R-squared	0.23	0.23	0.26

Note: The time span for the analysis is based on unbalanced dataset for the 1963-2010 period. ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. Robust standard errors clustered by country are presented in the parentheses.

Appendix 5-B: Principal Commodity Price Shocks and Political Regimes

For the replication analysis of the relationship between resource windfalls and political system, the investigation employs changes in principal export commodity price measurement constructed following Caselli and Tesei (2011). In particular, the measurement of resource windfalls at country level is computed as follows. First, for each country and for each year that data is available, all commodities are ranked by their value (share) of exports. The commodity that is ranked first in the largest number of years within country is identified as country's principal commodity (see Appendix Table 5-B1). Finally, each country's principal commodity is matched with an annual time series of that commodity's world prices (not indices). The data for export values and commodity prices are from the United Nation's Comtrade and IMF International Financial Statistics (IFS) dataset respectively.

The estimated specification used is identical to the one employed in columns 3 and 4 of Table 3 as in Caselli and Tesei (2011) where the dependent variable, measured as one year change in *polity2*, responses to the lagged change in the price of the principal commodity averaged over the previous three years, i.e. if the change in *polity2* is measured between years *t-1* and *t*, the change in commodity prices is the average over the years *t-4*, *t-3*, *t-2* and *t-1*. The construction of interaction terms is accomplished firstly by separating out the price change variable into two variables according to the initial levels (measured as four year lags or year *t-4* in order to be consistent with starting date for the price shock) of political contestability: the first is an interaction between the change in principal export commodity price and a dummy for autocracy, and the second is an interaction with a dummy for democracy. Then the full specification includes initial levels of *polity2* (separated into two by interacting with autocracy and democracy dummies) both, by themselves and interacted with the (autocracy/democracy specific) principal commodity price change.

The first two columns in Appendix Table 5-B2 present the results from this replication exercise where column 1 estimates the non-linear relationship between resource windfalls and political system using OLS, while column 2 employs the GMM system estimator. The results are consistent with original findings where commodity price shocks have significant negative impact on politics only in autocratic countries, which is decreasing in initial level of autocracy.

In addition to the replication analysis, the subsequent two columns estimate this relationship non-linearly conditional also on initial political violence/stability levels. Firstly, the specification reported in column 3, in addition to separating the resource shocks into autocracy/democracy specific price changes according to a country's initial political contestability levels, also includes the initial level of political violence/stability, both by itself and interacted with the autocracy/democracy specific principal commodity price change; while column 4 re-estimates the effect of price shocks for the subsamples with high (low) political violence levels by interacting autocracy/democracy specific price shocks with a dummy that takes the value of unity if a country's initial political violence level is below (above) the sample mean and zero otherwise.

The results from the non-linear estimation of these relationships provide support for the original findings, and indicate that positive shocks in commodity prices have a negative direct impact on political system in politically violent autocracies, which is marginally increasing while within-country political violence level decreases. Stratifying this association for the subsamples reveals that the significant consequences from price shocks is only the case for politically unstable autocratic countries, while resource windfalls have no impact on politics when they occur in democracies and in politically stable autocracies.

Table 5-B1: Countries by Principal Commodity

Princ. Comm.	No. Countries	Countries
Aluminium	9	Bahrain, Germany, Guinea, Jamaica, Lebanon, Mozambique, Slovakia, Slovenia, Switzerland
Bananas	2	Honduras, Panama
Beef	4	Burkina Faso, Djibouti, Ireland, Mali
Coal	3	Australia, Czech Republic, Poland
Cocoa	2	Cote d'Ivoire, Ghana
Coconut oil	1	Philippines
Coffee	13	Brazil, Burundi, Colombia, Costa Rica, El Salvador, Ethiopia, Guatemala, Haiti, Madagascar, Nicaragua, Rwanda, Tanzania, Uganda
Copper	5	Botswana, Chile, Papua New Guinea, Peru, Zambia
Cotton	2	Lesotho, Pakistan
Fish	5	Bangladesh, Cape Verde, Denmark, Korea Rep., Namibia
Gasoline	1	Italy
Groundnuts	3	Gambia, Guinea-Bissau, Sudan
Groundnuts oil	1	Senegal
Pig iron	6	Albania, Armenia, Bhutan, Georgia, Japan, Ukraine
Iron ore	3	Liberia, Mauritania, Sierra Leone
Jute	1	Nepal
Natural Gas	3	Belgium, Bolivia, Netherlands
Oil	31	Algeria, Angola, Azerbaijan, Cameroon, China, Congo Rep., Ecuador, Egypt, Gabon, Indonesia, Iran, Kazakhstan, Kuwait, Libya, Malaysia, Mexico, Nigeria, Norway, Oman, Qatar, Russia, Saudi Arabia, Syria, Trinidad and Tobago, Tunisia, UAE, United Kingdom, Venezuela, Vietnam, Yemen
Oranges	2	Israel, Spain, Turkey
Palm kernel oil	1	Benin
Phosphates	3	Jordan, Morocco, Togo
Pulp	1	Portugal
Rice	1	Thailand
Rubber	2	Cambodia, Singapore
Silver	1	South Africa
Soybean	2	Paraguay, United States
Sugar	5	Dominican Rep., Fiji, Guyana, Mauritius, Swaziland
Sunflower oil	1	Moldova
Tea	3	India, Kenya, Sri Lanka
Tobacco	5	Cyprus, Greece, Kyrgyzstan, Malawi, Zimbabwe
Uranium	1	Niger
Wheat	2	Argentina, France
Wood	8	Austria, Canada, Central African Rep., Finland, Latvia, Lithuania, Romania, Sweden
Wool	2	New Zealand, Uruguay

Table 5-B2
Commodity Price Shocks and Political Regimes
Dependent variable: Change in Political System (Δ polity2)

	(1)	(2)	(3)	(4)
$\Delta\ Pr_d$	-0.042	-0.208	-2.030	
	(0.516)	(0.631)	(1.365)	
$\Delta\ Pr_a$	-1.629**	-1.898**	-3.316*	
	(0.765)	(0.761)	(1.872)	
$\Delta\ Pr_d * Pl_{t-4,d}$	0.031	0.059		
	(0.057)	(0.076)		
$\Delta\ Pr_a * Pl_{t-4,a}$	-0.185*	-0.221**		
	(0.111)	(0.110)		
$\Delta\ Pr_d * Violence_{t-4}$			0.190	
			(0.143)	
$\Delta\ Pr_a * Violence_{t-4}$			0.356*	
			(0.202)	
$\Delta\ Pr_d * Violence_{high}$				-0.896
				(1.116)
$\Delta\ Pr_d * Violence_{low}$				0.098
				(0.343)
$\Delta\ Pr_a * Violence_{high}$				-1.710*
				(0.939)
$\Delta\ Pr_a * Violence_{low}$				0.628
				(0.620)
$Pl_{t-4,d}$	-0.095***	-0.144**		
	(0.015)	(0.067)		
$Pl_{t-4,a}$	-0.074***	-0.044		
	(0.017)	(0.041)		
$Violence_{t-1}$			-0.088	
			(0.064)	
Estimation method	OLS	GMM	GMM	GMM
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Countries/Observations	135/5036	135/5036	119/2419	119/2419
Specification tests				
(a) Hansen Test:		0.993	0.483	0.772
(b) Serial Correlation:				
First-order		0.000	0.000	0.000
Second-order		0.242	0.746	0.730

Note: The time span for the analysis in columns 1 and 2 is based on unbalanced dataset for the 1963-2010 period (T=47), while in columns 3 and 4 for the 1984-2010 period (T=26). ***, **, * represent significance of estimates, respectively, at 1%, 5% and 10% levels. The dependent variable is the *t-1* to *t* change in *polity2*. The method of estimation in columns 1 and 2-4 are, respectively, least squares and system-GMM. Robust standard errors presented in the parentheses for the least squares estimation are clustered at country level, while system-GMM estimation applies the Windmeijer (2005) small-sample correction.

Table 5-B3: Big Producers by Principal Commodity

Princ. Comm.	No. Countries	Countries
Aluminium	4	Bahrain, Germany, Lebanon, Mozambique
Beef	1	Ireland
Coal	2	Australia, Poland
Cocoa	2	Cote d'Ivoire, Ghana
Coconut oil	1	Philippines
Coffee	7	Brazil, Colombia, Costa Rica, Ethiopia, Guatemala, Nicaragua, Uganda
Copper	4	Chile, Papua New Guinea, Peru, Zambia
Cotton	1	Pakistan
Fish	2	Bangladesh, Korea Rep.
Groundnuts	2	Gambia, Sudan
Groundnuts oil	1	Senegal
Pig iron	2	Japan, Ukraine
Iron ore	1	Mauritania
Jute	1	Nepal
Natural Gas	1	Netherlands
Oil	12	Algeria, China, Indonesia, Iran, Kuwait, Mexico, Nigeria, Norway, Russia, Saudi Arabia, UAE, Venezuela
Oranges	2	Spain, Turkey
Phosphates	2	Jordan, Morocco
Rice	1	Thailand
Rubber	1	Cambodia
Soybean	2	Paraguay, United States
Tea	3	India, Kenya, Sri Lanka
Tobacco	2	Malawi, Zimbabwe
Uranium	1	Niger
Wheat	1	France
Wood	3	Canada, Finland, Sweden
Wool	1	New Zealand

Note: Large producers reflect countries (63) whose principal net export commodity production share belongs to the list of top 15 biggest producers in the world by commodity. Data for production of commodities by country are obtained from the following sources: aluminium, copper, pig iron and iron ore from the United States Geological Survey; phosphates and uranium from the British Geological Survey; beef, cocoa, coconut oil, cotton, fish, jute, oranges, rice, tea, tobacco, wheat, wood and wool from the Food and Agricultural Organization; rubber from the Association of Natural Rubber Producing Countries; groundnuts, groundnuts oil and soybeans from the US Department of Agriculture; coffee from the International Coffee Organization; oil, natural gas and coal from the US Energy Information Administration.

Appendix 5-C: Data Description, Sources and Coverage

Commodity export and import values for 1990 are collected from the United Nation's Commodity Trade Statistics Database. For countries with missing 1990 net export values, the analysis employs net export values available in the year closest to 1990 where the maximum distance from 1990 ranges in ±10 years interval.[114] Annual world commodity price indices are initially collected for 59 commodities from International Financial Statistics (IFS series 74 and 76), except for the natural gas and gasoline, which are from the United States Energy Information Administration (EIA 2013, 9.4 and 9.10); and pig iron obtained from the United States Geological Survey. However, commodities of olive oil, poultry, swine meat, urea and uranium were left out of the sample due to lack of adequate data in the early sample periods. Therefore the results for countries, in which the weights of these commodities over the export share are relatively important (e.g., Niger), should be interpreted with caution.

IFS price series have gaps for some commodities. Since the identical sample length is an important consideration for constructing the commodity price index measure, the analysis employed a combination of methods to generate missing values. For instance, the IFS price series for bananas and pepper are available only from 1975 and 1983 respectively; therefore missing values for the previous periods were replaced with the data from UNCTAD since the price series from both sources are almost identical. Three price series (coal, plywood and tobacco) have short gaps at the beginning of the sample period. Following Dehn (2000), these gaps were filled by holding the price constant at the value of the first available observation. Palm-kernel oil series have one missing value in the middle which was filled by linear interpolation. Missing values for oranges and barley (1962-1975) are replaced first with the rescaled price data available from FAOSTAT (Food and Agriculture Organisation) for the period 1966-1975, where the gap for 1962-1966 period was then filled by holding the price constant at the 1966 value.

[114] Any biases that might be generated by this choice are checked by re-estimating the main findings for the sample where countries with missing 1990 net export shares are removed. In all cases, the results remain robust at conventional significance levels.

For price series with missing values for which other highly correlated price series are available, the missing values are generated using partial adjustment regression equation:

$$\ln\left(\frac{X_t}{Y_t}\right) = \theta_0 + \theta_1 \ln\left(\frac{X_t}{Y_t}\right) + \theta_2 \ln(Y_{t-1}) + \varepsilon_t$$

where X_t is the series with missing early values and Y_t is a highly correlated series with a full set of observations. The regression is run on overlapping observations, and the coefficients are then used to "backcast" the missing observations. This method is used to fill the initial gap of 17 observations in the fish series and 8 observations in pulp series. The close correlates used were IFS fishmeal prices and plywood prices respectively.

Appendix 5-D1: List of Countries

Code	Country	Code	Country	Code	Country
1	Albania $_{c}$	46	Ghana	91	Norway $_{c}$
2	Algeria	47	Greece $_{c}$	92	Oman
3	Angola	48	Guatemala	93	Pakistan
4	Argentina	49	Guinea	94	Panama
5	Armenia $_{c}$	50	Guinea-Bissau	95	Papua New Guinea
6	Australia	51	Guyana $_{c}$	96	Paraguay
7	Austria $_{c}$	52	Haiti	97	Peru
8	Azerbaijan	53	Honduras	98	Philippines $_{c}$
9	Bahrain $_{c}$	54	India $_{c}$	99	Poland $_{c}$
10	Bangladesh	55	Indonesia	100	Portugal
11	Belgium $_{c}$	56	Iran	101	Qatar $_{c}$
12	Benin $_{cg}$	57	Ireland $_{c}$	102	Romania
13	Bhutan $_{cg}$	58	Israel $_{c}$	103	Russia
14	Bolivia	59	Italy $_{c}$	104	Rwanda $_{cg}$
15	Botswana $_{c}$	60	Jamaica $_{c}$	105	Saudi Arabia $_{c}$
16	Brazil $_{c}$	61	Japan $_{c}$	106	Senegal
17	Burkina Faso	62	Jordan	107	Sierra Leone
18	Burundi $_{cg}$	63	Kazakhstan $_{c}$	108	Singapore $_{c}$
19	Cambodia $_{cg}$	64	Kenya	109	Slovak Rep. $_{c}$
20	Cameroon	65	Korea Rep. $_{c}$	110	Slovenia
21	Canada $_{c}$	66	Kuwait	111	South Africa
22	Cape Verde $_{cg}$	67	Kyrgyzstan $_{cg}$	112	Spain
23	Central African Rep. $_{cg}$	68	Latvia $_{c}$	113	Sri Lanka
24	Chile	69	Lebanon	114	Sudan $_{c}$
25	China	70	Lesotho $_{cg}$	115	Swaziland $_{cg}$
26	Colombia $_{c}$	71	Liberia	116	Sweden $_{c}$
27	Congo, Rep.	72	Libya	117	Switzerland $_{c}$
28	Costa Rica $_{c}$	73	Lithuania $_{c}$	118	Syria
29	Cote d'Ivoire	74	Madagascar	119	Tanzania
30	Cyprus	75	Malawi $_{c}$	120	Thailand
31	Czech Republic $_{c}$	76	Malaysia	121	Togo
32	Denmark $_{c}$	77	Mali	122	Trinidad and Tobago
33	Djibouti $_{cg}$	78	Mauritania $_{cg}$	123	Tunisia
34	Dominican Republic	79	Mauritius $_{cg}$	124	Turkey
35	Ecuador	80	Mexico	125	Uganda
36	Egypt	81	Moldova	126	Ukraine $_{c}$
37	El Salvador	82	Morocco	127	United Arab Emirates $_{c}$
38	Ethiopia	83	Mozambique	128	United Kingdom
39	Fiji $_{cg}$	84	Namibia $_{c}$	129	United States
40	Finland $_{c}$	85	Nepal $_{cg}$	130	Uruguay
41	France	86	Netherlands	131	Venezuela
42	Gabon	87	New Zealand $_{c}$	132	Vietnam
43	Gambia	88	Nicaragua	133	Yemen
44	Georgia $_{cg}$	89	Niger	134	Zambia $_{c}$
45	Germany $_{c}$	90	Nigeria	135	Zimbabwe

Note: Subscripts *c* and *g* represent countries those are excluded, respectively, from the conflict onset and growth analysis when political violence/stability variable is employed.

Appendix 5-D2: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP per capita (log)	5735	8.29	1.31	5.08	11.82
GDP per capita growth rate	5735	0.02	0.07	-0.81	0.64
Trade over GDP	5399	0.69	0.45	0.05	5.62
Inflation (log (1+inflation rate))	4800	0.12	0.28	-0.12	4.77
Reserves over GDP	5397	0.05	0.06	0.00	0.52
Polity2	5654	1.51	7.37	-10	10
Δ Polity2	5642	0.09	1.78	-18	16
Δ Principal Commodity Price	5717	0.04	0.25	-1.04	1.58
Composite Commodity Price Index	5735	1.09	0.17	1.00	2.75
Unlogged unweighted index (1980=100)	5735	82.37	43.06	3.89	693.06
Commodity Exports to GDP (net)	5735	0.06	0.09	0.00	0.54
Δ Commodity Price Index	5735	0.001	0.011	-0.184	0.193
Δ Point source Commodity Price Index	5519	0.001	0.010	-0.127	0.193
Δ Diffuse source Commodity Price Index	5735	0.000	0.001	-0.017	0.035
Δ Energy source Commodity Price Index	3023	0.001	0.013	-0.069	0.192
Δ Non-Energy source Comm. Price Index	5735	0.000	0.005	-0.061	0.084
Political Violence/Stability	3036	8.73	2.52	0	12
Civil Conflict Onset	1709	0.05	0.21	0	1

Note: Summary statistics are based on panel country averages for the period of 1963-2010 and a sample of 135 countries, except the last two. Political violence/stability and civil conflict onset statistics are restricted to the period of 1984-2010 and summarized for 119 and 77 countries data set respectively.

Appendix 5-D3: List of Commodities

Non-agricultural				
Aluminium	Gasoline	Lead	Oil	Tin
Coal	Pig Iron	Natural Gas	Phosphatrock	Zinc
Copper	Iron ore	Nickel	Silver	
Agricultural				
Bananas	Cotton	Linseed oil	Pulp	Soybeans
Barley	Fish	Maize	Rice	Sugar
Beef	Fishmeal	Oranges	Rubber	Sunflower oil
Butter	Groundnuts	Palm-kernel oil	Shrimp	Tea
Cocoa	Groundnuts oil	Palm oil	Sisal	Tobacco
Coconut oil	Hides	Pepper	Sorghum	Wheat
Coffee	Jute	Plywood	Soybean meal	Wood
Copra	Lamb	Potash	Soybean oil	Wool

Note: The categorisation of point source commodities is identified as all non-agricultural commodities plus coffee, cocoa, sugar and bananas. Energy source categorisation includes coal, gasoline, natural gas and oil.