Growth, Poverty and Environment: The Role Played by Political Regime and Financial Development

Maurizio Intartaglia

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Department of Economics
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Abstract

This thesis explores three themes: (i) the relationship between income inequality and economic growth across democracies and non-democracies; (ii) the effect of financial development on poverty reduction; (iii) the differential impact of the main factors underling CO_2 and SO_2 emissions across political regimes.

Chapter One gives the overall introduction, including the literature review, the gaps in the literature and my contributions to the literature.

Chapter Two examines the relationship between inequality and growth across democracies and non-democracies using data covering the period from 1970 to 2005. The analysis provides evidence that income inequality has a significant and negative impact on growth irrespective of the kind of political regime. However, the results show the existence of non-linearities, where the impact of income inequality turns negative to positive as a country's level of income increases. Finally, the elasticity estimates suggest that income inequality has an economically stronger impact on growth under non-democracies than under democracies.

Chapter Three assesses the impact of financial development on poverty for the period spanning 1985-2008. The analysis provides evidence that financial development has a beneficial impact in terms of lowering the headcount index and poverty gap based on the $2 and $1.25 a day poverty lines. This effect holds only for some of the measures used to proxy financial development. On the other hand, the effect of financial development on relative poverty, as measured by the income share of the poorest 20% of the population, is statistically insignificant, regardless of the index of financial development.

Chapter Four quantifies the impact of the main driving forces underling CO_2 and SO_2 emissions across political regimes. Depending on the air pollutant and the political regime, the relationship between per capita GDP and emissions levels is either linear or inverted-U shaped. The estimates display that the adverse impact of increasing levels of population on air quality is generally less strong under non-democracies than under

democracies. Conversely, the adverse impact of greater trade openness is stronger under non-democracies than under democracies. Finally, the impact of youth on SO_2 emissions turns out to be statistically significant for democracies only.

Chapter Five provides the overall conclusion, discusses the findings, limitations of the analysis and potential areas for future research.

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Chapter 1 : Introduction

It is a common practice to look at the increase in per capita Gross Domestic Product (GDP) to assess countries' relative economic performance. Countries with a faster growth of per capita GDP are thought to perform better than countries with relatively low growth rate. Alongside economic growth there has been an increased focus on other issues, specifically the distribution of wealth, alleviation of poverty and the preservation of the environment. The following quotation taken from the website of the Earth Summit held in Johannesburg in 2002 gives an idea of the emphasis placed on such issues: "The Summit reaffirmed sustainable development as a central element of the international agenda and gave new impetus to global action to fight poverty and protect the environment. The understanding of sustainable development was broadened and strengthened as a result of the Summit, particularly the important linkages between poverty, the environment and the use of natural resources" (www.johannesburgsummit.org). Such a statement expounds the multi-dimensional nature which nowadays characterizes the notion of development: when assessing a country's overall performance one has to focus on a variety of aspects, including the economic growth rate, poverty alleviation and environmental sustainability.

An enormous body of theoretical and empirical work has accumulated over the last few decades in an attempt to pinpoint the factors which underlie countries' economic and environmental performance. Within this body of literature there are an ever increasing number of studies that have emphasized the importance of institutions (e.g. North and Thomas, 1973; North, 1990; Rodrik, 2002; Acemoglu, 2004). According to this strand of literature, the ultimate factor underlying the incentives of the economic actors lies within the institutional framework. In North's words "Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction" (1990, p. 3). In the next passage North adds "they [the institutions] structure incentives in human exchange, whether political, social, or economic" (p. 3). Thus, in this tradition the study of institutions is a matter of the utmost importance for a clear understanding of how to start and maintain a process of sustained development. The current thesis belongs to this strand of literature. Specifically, I empirically investigate the role of a specific set of institutions, namely the political regime and

financial sector, in shaping countries' economic growth, poverty reduction and environmental quality. The thesis is structures as follows: (i) Chapter Two assesses whether and how a country's political regime affects the relationship between economic growth and inequality; (ii) Chapter Three explores the impact of the development of a country's financial sector on poverty alleviation; (iii) Chapter Four explores the role played by the type of political regime in shaping the impact of the factors commonly viewed as the main forces underlying CO_2 and SO_2 emissions.

What makes this analysis interesting are the peculiarities which characterize the institutions under investigation. Specifically, a liberal political regime as well as an efficient financial sector might be seen as aims to be achieved in themselves because of aspects of equity and/or efficiency that they enhance. As regards political regime, democracy has enjoyed a surge of interest in the academic community due to its form of government which is the most likely to respect human rights and promote political freedoms. In light of such intrinsic merits, assessing the economic and environmental performance of democracy relative to non-democratic political regimes is clearly a topic of primary importance. If authoritarian regimes turn to be more capable of promoting a given dimension of development, for example economic growth, then one has to bear in mind that political freedoms, notwithstanding their desirability, entail some opportunity costs.[1] This is exactly the kind of argument which underlies Bhagwati's thesis whereby "the political economy of development poses a cruel choice between rapid expansion and democratic processes" (1966, p. 203-204). On the other hand, if democracies perform relatively better than non-democracies, then one can happily conclude that political freedoms not only are inherently desirable, but also economically/environmentally valuable. A third result might be a kind of "neutrality" of political regime, in which case political freedoms would entail no costs in terms of the designed economic/environmental output, nor they would provide comparative advantages over autocratic form of government.

With regards to the financial sector, a large body of literature has shown that a system which effectively provides financial services, such as risk amelioration, saving mobilization and capital allocation, is crucial for the process of economic growth (e.g.

[1] The terms non-democracy, dictatorship and autocracy are used interchangeably in this study.

King and Levine, 1993; Beck *et al*., 2000; Beck and Levine, 2004). Thus, there is a large consensus that the process of financial development provides valuable real services which boost the overall efficiency of the economic system. On the other hand, the relationship between financial development and poverty is far less documented than the growth-financial development nexus. Theoretically, if a mechanism of trickle-down is at work, it is reasonable to expect that financial development will benefit the poor indirectly, by increasing the growth rate of an economy. In addition, financial development could relieve poverty directly by expanding the access to credit toward poor households. Then, financial development would promote not only efficiency (more growth) but also equity (less poverty). However, as it will be explained below, there are theoretical reasons which cast doubts on whether financial development could really have a beneficial impact on poverty alleviation. In fact, it turns out that the nature of this impact depends on the definition of poverty. Specifically, it might be the case that financial development helps a number of poor households to move out a given threshold of absolute poverty (less "absolute" poverty). However, this does not necessary implies that financial development will increase the share of the "pie" joined by the poorest portion of the population (less "relative" poverty).

Admittedly, the study of the economic and environmental impact of the institutions under analysis is not new and indeed, a large strand of empirical literature has focused on this topic. However, as it will be explained below, I believe that further research on these issues is needed because of the limitations that beset previous analyses. The main contribution of this thesis is to readdress such issues while overcoming some of the theoretical and methodological difficulties which characterize prior literature. In the rest of the introduction, I briefly outline the research questions, illustrate the relevant strands of literature along with limitations, and highlight the specific contributions of Chapters Two, Three and Four. In addition I illustrate the methodology used throughout the study, namely the system GMM panel method. Key findings, limitations, policy insights and potential extensions are illustrated in Chapter Five.

Chapter 2: The Impact of Income Inequality on Growth: A Sensitiveness Analysis across Different Political Regimes

In late 18th-century and early 19th-century political theorists such as David Ricardo, J.S. Mill, Thomas Macaulay and Daniel Webster were all sceptical about the compatibility of widespread political freedom with a process of fast growth. Specifically, they shared the feeling that a widespread franchise trades off the security of private property necessary for investment and economic growth. A combination of unequal distribution of income and universal suffrage would have lead "exploitation of the rich by the poor", with negative repercussions on the overall economic performance. This implies that democracy hampers the growth of the economy.

More recently, the literature has incorporated such thinking in the median voter framework which formalizes the determination of tax rates based on majority rule. For instance, Alesina and Rodrik (1994) and Persson and Tabellini (1994) extend the endogenous fiscal model of Meltzer and Richard (1981) to a dynamic context based on overlapping generation framework. According to their models, higher levels of income inequality worsen conflicts over distributional issues. Under majority rule, such fiscal pressure eventually leads the effective tax rate to rise above some threshold level which maximizes investment and growth. As a result of excessive taxation, higher inequality would lower the country's rate of economic growth. There are two mechanisms at work here: a political mechanism by which fiscal pressure ends up with redistributive policies; and an economic mechanism whereby redistribution harms growth as a result of the distortions that taxes cause to the economy. Such framework relating inequality and growth via taxation policy have been quoted as "fiscal policy approach" (Perotti, 1996) or "political-economic model" (Barro, 2000).

On the other hand, a similar relationship is not predicted for undemocratic regimes because the linkage between income inequality and fiscal policy here is ambiguous. Persson and Tabellini point out that "in a society where distributional conflict is more important, political decisions are likely to result in policies that allow less private appropriation and therefore less accumulation and less growth. But the growth rate also depends on political institutions; for it is through the political process that conflicting interests ultimately are aggregated into public-policy decisions" (Persson and Tabellini,

1994, p. 600). Since policy makers in undemocratic countries are not elected on the basis of majority-rule, the "median" voter no longer plays a pivotal role. As a result of this, fiscal policies implemented in undemocratic regimes could be disconnected from the distribution of wealth. From a theoretical side, the extension of the franchise to a larger fraction of the population decreases the income of the "decisive" voter, thereby strengthening the support for redistributive policies. Therefore, such line of reasoning predicts a harmful impact of income inequality on growth in democracies while the adverse effect of inequality is thought to be weaker or absent in dictatorial countries.

One weakness underlying the political-economic model is the omission of credit rationing. To understand the implications of this assumption, suppose a simple economy where production is proportional to an asset, named "capital", whose productivity exhibits diminishing marginal returns.[2] One important consequence of this technology is that transferring one unit of capital from an individual with an abundant capital endowment (rich) to an individual who lacks capital (poor) leads to an increase in the aggregate level of production. If capital markets work perfectly, those who need capital borrow from those who are in excess. Thus, the rate of capital return at the margin is equal for all individuals and the economic system operates at its maximum capacity. In such circumstances, a non-lump sum redistribution of capital necessarily entails a loss in efficiency because it reduces the return on capital, therefore the accumulation rate of capital.

On the other hand, the growth-effect of redistribution might be quite different if some agents are prevented from obtaining credit due to the presence of credit market imperfections. Under such circumstances, the return of capital is not equated at the margin across all the individuals, and the economy works below its maximum capacity.[3] Hence redistribution could work as a remedy to a market failure. Specifically, a redistribution of capital toward the individuals whose investment projects offer the highest return on capital, namely the "poor", can raise the overall efficiency of the economy, notwithstanding the adverse impact of taxation on the incentives to save and invest by the rich.

[2] The individuals' endowment can be physical as well as human capital.
[3] The argument based on credit market imperfections is shared by several works which point an adverse effect of inequality on growth (e.g. Galor and Zeira, 1993; Banerjee and Newman, 1993; Aghion and Bolton, 1997).

On the empirical front, there are a number of studies which have investigated the relative strength of the relationship between inequality and growth across democracies and dictatorships. Persson and Tabellini (1994) show that the negative impact of inequality on growth holds for a sample of democratic countries while it turns statistically insignificant for non-democracies. On the other hand, using a different inequality dataset and classification of political regimes, Deininger and Squire (1998) find the reverse, namely that inequality is harmful to growth for dictatorships but not for democracies. Other studies, such as Alesina and Rodrick (1994), Clarke (1995) and Perotti (1996), reveal that the effects of inequality on economic growth are negative and statistically significant regardless of the kind of political regime.

Overall, the evidence of a differential impact of inequality on growth across democracies and dictatorships is, at best, mixed. One possible reason for such variety in these results is concerned with the measurement error problem. As shown by Weed (1997) and Knack and Keefer (1997), the empirical results found by Persson and Tabellini are an artefact of their data on income distribution and political regime classification. However, I believe that poor quality data of income distribution is unlikely to be confined to this study. Specifically, the income inequality dataset used by Deininger and Squire (1998) does improve over the data used by previous studies, yet it still suffers from serious problems which might invalidate comparability across countries (Atkisnon and Brandolini, 2001).

Additional important reasons for the contrasting findings are methodological and econometric limitations. The afore-mentioned studies employ standard cross-country regressions which assess the impact of initial levels of inequality on subsequent growth spanning 20 years or more. However, cross-country regressions do not control for unobserved country-level effects. In the presence of correlation between these effects and the explanatory variables, which is quite likely in large sample of countries, the coefficient estimates are biased. Moreover, pure cross-sectional analyses fail to exploit any piece of information available in the time-series dimension of the data. Finally, all these studies have tested the relationship between inequality and growth using a standard linear growth model. However, as shown by later analyses, such as Barro (2000), Lin *et al*. (2009) and Castelló (2010), the assumption of linearity might not be well-grounded. Specifically, these studies find that the effect of inequality on growth is

negative in poor countries while it is statistically insignificant or even positive in richer countries. I believe that such non-linearity might play a relevant role in shaping the relative strength of the growth effect of inequality across political regimes. Specifically, if redistribution works as a substitute for credit market imperfections, democratic institutions should mitigate the negative effect of inequality precisely in economies with serious credit imperfections, namely poor countries – given that democracies are (generally) more sensitive to distributional issues than dictatorships. On the other hand, the differential effect of inequality on growth across political regimes is more ambiguous where problems of asymmetric information are mitigated by the working of a well-developed financial sector, namely high-income economies.

This chapter contributes to yield a better grasp of the relationship between inequality and growth by attempting to overcome some of the problems reported in the previous empirical literature. First, it uses the newly assembled data on inequality developed by the University of Texas Inequality Project (UTIP). This dataset is constructed by combining the information for pay inequality in the manufacturing sector provided by the United Nations Industrial Development Organization (UNIDO) and the information in the "high quality" subset of the Deininger and Squire data set. Unlike the previous dataset, the measure of income inequality provided by UTIP is comparable and consistent across both years and countries. Secondly, it uses a longitudinal approach and dynamic panel techniques which overcomes the problem of omitted variable bias due to the presence of unobserved country-level effects. Along with the cross dimension of the data, such an approach makes use of additional pieces of information from variation over time. Finally, to allow for non-linearity between inequality and growth, it includes in the set of regressors an interaction term between the level of income and the inequality variable. This can be viewed as a pioneering work using a panel technique and non-linear model to assess the comparative strength of the relationship between inequality and growth across democracies and non-democracies.

Chapter 3: Absolute Poverty, Relative Poverty and Financial Development

In recent years an increasing body of literature has focused on whether and how the development of the financial system affects the standard of living for the poor. Some important theoretical models argue that poor families are likely to remain so due to the

presence of credit market imperfections (e.g, Galor and Zeira, 1993; Banerjee and Newman, 1993; Aghion and Bolton, 1997). Rather than channelling the funds toward those with the most profitable investments, financial markets lend funds to those with large endowments of assets. As a result, poor families forgo (human or physical) investments because they are unable to collect the necessary funds to finance themselves. One potential way of alleviating poverty is to undertake public policies which redistribute resources from the wealthy to the poor. However, such a policy approach entails some costs because of the adverse effect it has on the incentives, to save and invest, for those who carry the burden of taxation.[4] On the other hand, if financial development is pro-poor, the policy maker could use an alternative approach to tackle poverty which does not share the same incentive problem associated with redistributive policies. Specifically, policies which lead to financial development would promote both equity and efficiency with no distortions on investments.

On the theoretical side, financial development could reduce poverty by increasing the level of credit available to the poor. Specifically, advances in the financial system which ameliorate credit market imperfections could expand the set of economic opportunities of the poor but talented individuals who were previously unable to borrow (Demirgüç-Kunt and Levine, 2009, and the references therein). On the other hand, the benefits associated with increasing availability of credit might principally accrue to the insider, in which case a deepening in the financial system does not widen the access to credit to a larger proportion of the population (Claessens and Perotti, 2007). Even worse, a greater financial depth could narrow the access to credit if resources are being shifted from the informal to the formal sector – given that the poor obtain funds primarily from the informal sector (Arestis and Caner, 2009). In addition, if accompanied by a feeling of euphoria, expansions of the financial sector might increase financial fragility (Arestis and Caner, 2009). In such climate, banks are more likely to lend indiscriminately and firms to downplay the risks associated with investment projects. If the ensuing economic scenario does not match the expectations, a financial crisis is likely to occur. This scenario is particularly detrimental for those who pay the highest price of financial crisis, namely the poor.

[4] As explained above, redistributive policies still lead to an overall gain in efficiency if the 'incentive effect' to invest on the transfer recipients outweighs the disincentive effect to invest on the taxpayer. In fact, in a Keynesian context, a progressive redistribution might enhance not only poor's incentive to invest, but also the rich's incentives because of the increase in the aggregate demand driven by the poor's relative high propensity of consumption (the "acceleration principle", see e.g. Samuelson, 1939).

Financial development could mitigate poverty beyond its effect on the availability of financial services to the poor. Several studies have successfully established a positive impact of financial development on economic growth (e.g. King and Levine, 1993; Levine and Zervos, 1998; Beck *et al*., 2000; Fink *et al*., 2003; Beck and Levine, 2004). If a trickle- down effect is at work then the poor can benefit from financial development through the growth channel (Arestis and Caner, 2009). In addition, an increase in the rate of economic growth expands the resources on which redistributive policies can draw on. Financial development could also affect the income share of labour, which is the main source of income for the poor. Specifically, the poor could reap further benefits from financial development if the increase in the growth rate translates into a higher demand for low-skilled labour. On the other hand, if the expansion of economic activity involves primarily high skilled workers, the poor will remain untouched by the higher labour demand (Demirgüç-Kunt and Levine, 2009).

Using one or more proxies of financial development several empirical works, based on large sample of countries, suggest that financial development alleviates the *absolute* incidence of poverty - the most common measure of absolute poverty used being the headcount index, which gives the percentage of population living below a specified poverty line (Honohan, 2004; Beck *et al*., 2007; Akter *et al*., 2010; Perez-Moreno, 2011; Jeanneney and Kpodar, 2011). Some work has also been done to assess the impact of financial development on *relative* poverty, which is commonly measured as the income of the poorest 20 % of population relative to the national income (Jalilian and Kirkpatrick, 2005; Beck *et al*., 2007; and Jeanneney and Kpodar, 2011). The empirical evidence found by these studies is in favour of a positive impact of financial development on the income share of the poorest quintile. Taken together, such findings suggest that financial development has decreased not only the number of people below the poverty line, but it has also increased the share of the income accruing to the lowest quintile.

Overall, the theoretical ambiguity concerning the effect of financial development on poverty alleviation seems to have been settled empirically. However, the afore-mentioned studies suffer from serious methodological difficulties. For example, both Jalilian and Kirkpatrick (2005) and Beck *et al*. (2007) test the impact of financial development on poverty using a sample which includes developed as well as developing

countries. If richer countries have higher level of financial development as well as lower relative poverty, then running a pooled sample might produce misleading results. Both studies use an interaction term between the proxy of financial development and a dummy for poor countries or the level of GDP to account for a differential effect of financial development on poverty across different income levels. However, they do not use similar interaction terms for other explanatory variables, neither do they mention any check for testing whether the coefficients are equal across poor and rich countries. Honohan (2004) uses cross-sectional analysis to assess whether financial development leads to poverty reduction for a sample of 70 poor countries. However, cross-sectional regressions do not control for unobserved country-specific effects and discard any available information in the time-series dimension of the data. Jeanneney and Kpodar (2011) overcome these difficulties by using a system GMM estimator for a sample of 75 developing countries; however, they fail to include the lagged dependent variable in their set of explanatory variables, therefore, their empirical model potentially still suffers from omitted variable bias.

Honohan (2004), Akter *et al*., (2010) and Perez-Moreno (2011) use the headcount index based on the absolute poverty line as the only proxy for poverty. One problem with this approach is that absolute levels of poverty are not always too high, particularly in middle income economies, yet the distribution of wealth in developing countries is generally strongly uneven, with the bottom quintile of the population sharing only a very small fraction of the national income (e.g., Brazil, Argentina and Peru). Thus, the complementary information provided by measures of relative poverty is important for a proper assessment of the impact of financial development on the poor.

This study contributes to the literature on the nexus between financial development-poverty by focusing on two different dimensions of poverty, namely absolute and relative poverty, while overcoming some of the methodological problems encountered in previous studies. I believe that such distinction is important because the measurement of the pro-poor effect of financial development probably depend on the definition of poverty on which the researcher is focusing. Financial development might well help the poor to get out of a specific poverty line (for example, $2 a day). However, a reduction of absolute poverty does not necessarily imply a drop in relative poverty. In fact, the income share of the poorest X % of the population (for example the lowest quintile),

might even decrease if financial development favour disproportionately the richer fractions of the population. In other words, there is no reason to believe that a drop in absolute poverty might not be accompanied by an increase in relative poverty.

To assess empirically the impact of financial development on poverty I structure the analysis in the following way. First, I focus on a sample of developing countries only. As the structure of the financial sector could differ strongly across poor and rich countries, focusing on developing economies avoids an important source of heterogeneity from using pooled sample of both rich and poor countries. The exclusion of the sample of rich countries is even more important when studying the headcount index because the absolute levels of poverty for these countries, at the World Banks' stated poverty lines, are virtually zero. Second, the empirical estimation employ a longitudinal approach based on the system generalized methods of moments panel estimator (system GMM). This estimation technique effectively addresses the dynamics and controls for country-specific effects. Third, the analysis employs a large array of measures of financial development drawn from the literature on the financial development-poverty nexus. Specifically, to proxy for financial development I use the value of liquid liabilities, the total amount of credit granted to the private sector by financial intermediaries and the stock market capitalization (all expressed as a share of GDP), which are measures of the *size* of the financial sector. The other two indices, namely the ratio of commercial to central bank assets and the stock market turnover ratio, reflect mainly the *efficiency* and the degree of *liquidity* of the financial sector. Using these indices allows us to assess the effect on poverty of two different dimension of financial development, i.e. the financial deepening and the efficiency/liquidity with which the financial sector perform its functions.

Chapter 4: Determinants of CO_2 and SO_2 Emissions: Empirical Evidence for Different Political Regimes

Emissions of carbon dioxide (CO_2) and sulphur dioxide (SO_2) are among the main factors that are known to affect the natural environment and human health. Notably, high atmospheric concentrations of CO_2 are principally responsible for climate change. Likewise, SO_2 causes acid rain and several respiratory problems, such as bronchoconstriction and asthma symptoms. An ever increasing body of the literature

has focused on the anthropogenic factors underlying CO_2 and SO_2 emissions, such as economic growth, trade openness, technologies and population size (Grossman and Krueger, 1995; Dietz and Rosa, 1997; Heil and Selden, 2001; York *et al*., 2003; Cole and Neumayer, 2004; Fan *et al*,. 2006; Auci and Becchetti, 2006; Managi *et al*., 2009; Naryan and Naryan, 2010).[5] Within such literature, a large number of studies have analysed whether countries with democratic institutions are more concerned with environmental issues as compared to non-democratic countries.

Theoretically, there are several reasons to believe that democracies are relatively more capable of achieving higher environmental standards as compared to non-democratic countries. Some authors (McGuire and Olson, 1996; Lake and Baum, 2001; Bueno de Mesquita *et al*., 2003) have argued that the level of public goods provided by the state is higher under democracies than under non-democratic regimes. Since the characteristics of environmental quality, such as clean air and preservation of forest, are those of a public good, one would expect that environmental performance of democracy is superior to that of autocracy. Payne (1995) holds that environmental-interest groups are more successful in promoting environmental legislation where political and civil rights are protected. An additional argument revolves on the tendency of democracy to favour multilateral environmental cooperation (Neumayer, 2002). This propensity is especially important for addressing environmental problems which are global in character.

On the other hand, several scholars question the ability of democracy to provide effective solutions to environmental problems. Some influential writers, such as Hardin (1968) and Heilbronner (1974), invoke some kinds of constraint on freedoms as a remedy to the increasing scarcity of resources and individuals' propensity to over exploit the common good. This type of task might be more easily achieved in non-democracies because of the greater degree of autonomy that the policy maker enjoys as compared to democratic forms of government. In a similar vein, Desai (1998) is sceptical about whether political freedoms could positively affect environmental quality because of the democracies' dependency on economic growth – given a general adverse impact of growth on the environment. Furthermore, to the extent that the costs from

[5] Carbon and sulphur emissions on the atmosphere have a natural as well as an anthropogenic component. Examples of natural sources are volcano eruptions and respiration process by living organism. The anthropogenic component comes from man-made sources, especially the combustion of fossil fuels for generating power.

environmental degradation manifest in the long run, myopic electors will not fully appreciate the importance of environmental policies. In such case, electoral accountability would be more of a hindrance than a stimulus to environmental preservation. As long as the ruling elite expect to remain in power for a long period of time, a dictatorship might turn to be environmental responsible precisely because it does not face frequent re-elections (Bernaeur and Koubi, 2009).

Looking at the empirical evidence, with the partial exceptions of Shafik and Bandyopadhyay (1992) and Midlarsky (1998), I find that prior studies have documented a beneficial impact of democracy on environment quality. Li and Reuveny (2006) and Winslow (2005), using the Polity score of democracy (Jaggers and Gurr, 1995), reveal that more democratic countries produce lower levels of CO_2 and SO_2 emissions per capita than less democratic countries. Bernauer and Koubi (2009) provide similar evidence using Bueno de Mesquita *et al*. (2003) measure of degree of democracy. Specifically, they find that a higher degree of democracy is conducive to lower levels of SO_2. Other studies such as Dutt (2009), Barret and Graddy (2000) and Scruggs (1998), have used the indices constructed by Freedom House as a proxy for the level of democracy (Gastil, 1987 and later issues). Their findings show that there is a negative impact of democracy on emission levels.

All the afore-mentioned studies are based on a reduced-form model which examines the direct effect of democracy on environmental outcome. However, as explained above, the level of emissions depends primarily on other factors such as population, the level of production and technologies. In practice, if democracies deliver better environmental outcomes than non-democracies, they should do so by successfully mitigating the adverse impacts of the driving forces underlying environmental degradation. This means that the effect of these driving forces might be conditional on the political regime. To give an example, let us consider the level of CO_2 and SO_2 emissions as a function of the size of population. It is reasonable to assume that the higher the population, the higher the emission levels, other conditions being equal. However, if institutional features, such as free flow of information, independence of the media and civil liberties, raise public consciousness of the problems associated with pollution, then it is possible that the environmental impact of increasing levels of population varies across different kinds of political regime. Specifically, individuals living in a democracy

are assumed to be more aware of the environmental consequence of their action as compared to their counterparts in dictatorships. Therefore, democratic institutions will encourage the adoption of conducts and technologies which minimize the adverse impact of rising demographical pressures. As a result of these institutional features, the emissions levels for a given level of population might be lower under democracies than under dictatorships.

This investigation proceeds in three steps. First, I quantify the impact of the level of income (proxied by per capita GDP), population size, the share of population aged less than 15 and trade openness, on CO_2 and SO_2 for a large sample of countries. These variables are widely thought to be among the main driving forces underlying CO_2 and SO_2 emissions. This model can be considered as the baseline specification. Second, after assessing the effects of these variables, I explore the differences in the environmental impact of the driving forces across democracies and dictatorships. I thus use a set of interaction terms between the explanatory variables and dummies for democracy and non-democracy. Third, I assess the differential impact across political regimes using a flexible functional form which allows the effects to vary depending on the stage of development. I do so by including the interactions between the explanatory variables (population, youth and openness) and the income variable (per capita GDP) into the specification. Finally, to gauge the sensitivity of emissions I compute the elasticity of emissions with respect to a specific underlying variable at different percentiles of the other variables in the model.

The main reason underlying the selection of CO_2 and SO_2 emissions as indices of environmental quality (degradation) is concerned with data availability. As the environment quality is a multidimensional concept it would have been preferable to use a composite index, such as the Environmental Performance Index, which is based on a large number of variables ranging from the percentage of population with access to drinking water to the emissions of carbon dioxide produced by the industrial sector (Esty *et al*. 2008). However, poor data coverage makes it difficult to use panel data methodology. Similarly, the availability of indices concerning other forms of environmental degradation, such as COD and BOD (measures of water quality), land degradation and deforestation, is restricted to small numbers of countries and/or time periods. On the other hand, the levels of emissions of carbon and sulphur dioxide are

available for a relative large sample of countries and time periods. In addition, CO_2 and SO_2 emissions can be seen as among the most important indices of air quality. I chose to focus on emissions instead of concentration of CO_2 and SO_2 because the emission levels are more closely concerned with economic activity than the concentration levels (see e.g. Cavlovic *et al*. 2000).

My work contributes to the existing empirical studies mainly in three key ways: (i) I assess the role played by political regime by looking at difference in the strength of the relationship between main anthropogenic factors and emissions across different types of political regimes; (ii) I use a categorical index of political regime from Alvarez *et al*. (1996) and later extended by Cheibub *et al*. (2010) which is based on a minimalist definition of democracy. Unlike continuous indices which focus on the *degree* of democracy, a dichotomous variable allows us to make a sharp contrast between different *kinds* of political regimes, namely democracy vis-à-vis dictatorships. In addition, such an index is not subject to the conceptual and methodological problems which underlie the operationalization of maximalist conceptions of democracy, such as the Polity IV and Freedom House measures (Cheibub *et al*. 2010); (iii) I estimate the empirical model in a dynamic framework using a system Generalized Method of Moment (GMM*)* approach, which allows us to overcome the dynamic bias problem from including the lagged dependent variable in the set of controls. Further, this methodology is also effective in controlling for unobserved country-specific time-invariant effects. To the best of my knowledge, this is the first work which uses the two-step system GMM estimator within the literature on the environmental performance of political regimes.

Methodology

My study employs a longitudinal approach which combines time series and cross-section dimension of the data. Specifically, the empirical estimations rely on a dynamic model as follows:

$$y_{it} = \alpha y_{it-1} + X_{it}^{'}\beta + \mu_i + v_{it} \qquad [1]$$

Where y_{it} is the dependent variable (e.g. growth rate of per capita GDP in Chapter Two), X_{it} is a set of explanatory variable which includes the main variable(s) of interest (e.g. income inequality in Chapter Two), μ_i is a country-specific effect and v_{it} is a idiosyncratic shocks. α and β denote the parameters to be estimated. As it can be seen, the set of regressors also includes the lagged dependent variable, y_{it-1}. This variable is precisely the main feature which characterizes a dynamic model. Such a specification allows the dependent variable to depend on its past realization which means that a change in x_i at time *t* will influence y_i also after that period. Such a dynamic pattern is a typical feature of factors which change slowly over time, as is indeed the case for the level of per capita GDP, the rate of poverty and the level of CO_2 and SO_2 emissions.[6]

The inclusion of the lagged dependent variable on the right hand side causes a "dynamic panel bias" which neither the OLS estimator nor static panel techniques are capable of addressing (Baltagi, 2008; Greene, 2008). Specifically, both OLS and random effects are inconsistent because the country-specific effects are by definition correlated with the (lagged) dependent variable. The within estimator is also inconsistent because of the correlation between the (within-transformed) lagged variable and the (within-transformed) error term (Nickell, 1981). Dynamic panel techniques overcome the dynamic panel bias because, under some conditions which are explained below, they allow IV estimation of the endogenous variable y_{it-1} using y_{it-2} and other past lags as instruments (Arellano and Bond, 1991; Arellano and Bover; 1995). In addition, dynamic panel techniques allows for endogeneity in *all* the explanatory variables included in X_{it} because the lagged values of each of the right hand side variables can also be used as additional IV instruments (Beck *et al*. 2000).

Once the superiority of dynamic panel techniques over alternative estimators has been ascertained, the researcher still has a choice between two alternative dynamic estimators, namely first-difference GMM and system GMM estimators. The main advantages of the latter over the former estimators can be summarized as follows:

[6] The reader can object that economic growth (the dependent variable in Chapter Two) is not the same as the level of GDP. In fact, the growth rate is nothing more than the first differences between two consecutive levels (in time) of GDP. When growth is written in first difference, it is easy to rewrite the regression with the level of per capita GDP as the dependent variable. This is explained in more detail in footnote 9 of Chapter Two.

1) First-differencing drops any variation across country, thereby discarding an important source of information.
2) Differencing intensifies the bias from measurement errors (Griliches and Hausman, 1986).
3) The difference GMM estimator suffers from "weak" instruments problem when the variables are persistent over time (Blundell and Bond, 1998).
4) Differencing magnifies the gaps in panel data (Roodman, 2006).
5) System GMM has better finite-sample properties than difference GMM (Baltagi, 2008).

Given the nature of the variables and the unbalanced structure of the panels under analysis I prefer system GMM to first-difference GMM. This technique had been first elaborated by Arellano and Bover (1995) and then fully developed by Blundell and Bond (1998). Specifically, the system Generalized Method of Moment approach estimates the equation [1] in levels jointly with the equation in first-difference:

$$\Delta y_{it} = \alpha \Delta y_{it-1} + \Delta X'_{it} \beta + \Delta v_{it} \qquad [2]$$

The estimator uses lagged values of the explanatory variables, in levels as well as in first-differences, as IV instruments for the respective equations ("internal" instruments). Unlike system GMM estimator, the first-difference GMM estimator is based exclusively on the equation [2] in first-difference. In order to use the system GMM an additional assumption is required. Specifically, the first-differences of the explanatory variables have to be uncorrelated with the fixed effect (Bond *et al.* 2001). If this assumption holds, then first-differences can be used as IV instruments for the additional equation in levels [1]. This assumption is testable with the Hansen test of over-identifying restrictions, as discussed below.

The GMM estimates have been obtained by using the user written "xtabond2" command in Stata (version 11). Two critical assumptions have to hold for the system GMM to be a valid estimator. First, it is required that the error term exhibits no serial correlation higher than order one. Second, the set of instruments have to be statistically independent from the disturbance process (orthogonality condition). The first

assumption can be tested with the Arellano and Bond test. The second assumption can be assessed in an over-identified context by the Hansen test of over-identifying restrictions. If both tests fail to reject their respective null hypotheses, then one can be reasonably confident that the system GMM is delivering valid estimates. To relax the assumption of homoskedasticity in the error terms I have relied on the two-step variant of the GMM estimator with the "Windmeijer finite-sample correction" (Windmeijer, 2006) (the "xtabond2" command followed by the "twostep" and "robust" options in Stata).[7]

[7] See Roodman (2006) for more details on system GMM and its implementation with Stata.

Chapter 2 : The Impact of Income Inequality on Growth: A Sensitiveness Analysis across Different Political Regimes

2.1. Introduction

The inequality-growth relationship is at the core of an intense debate on the compatibility between a steady process of economic growth and an even distribution of wealth (see, for example, Galbraith, 2012). An equally important issue is whether the association between income inequality and growth is the same across democracies and dictatorships, or whether in fact the effect of inequality on growth is conditional on the political regime.

According to the "political-economic model", income inequality has a significant role to play in shaping economic growth in democratic regimes, whereas such a relation is less obvious for non-democratic regimes. The negative effects of income inequality on growth for a democracy can be explained as follows. Since the median income is lower than the average in general, democratic regimes carry fiscal policies aimed at income redistribution by imposing higher taxes (Meltzer and Richard, 1981). Higher taxation discourages investment and hence reduces the growth rate of the economy (Bertola, 1993; Persson and Tabellini, 1994; Alesina and Rodrick, 1994). On the other hand, a similar relationship is not predicted for undemocratic regimes because the linkage between income inequality and fiscal policy is ambiguous. In fact, since the median voter no longer plays a pivotal role, the adverse effect of inequality on growth should be weaker or absent in dictatorships.

On the empirical ground, there are a number of studies which have investigated whether income inequality affects economic growth differently across democracies and dictatorships. Persson and Tabellini (1994) analyse the effects of income inequality on growth for a sample of about 49 countries between 1960 and 1985. They find that the negative impact of inequality is statistically significant for the sample of democratic countries while it turns out to be insignificant for non-democracies. On the other hand, using a different inequality dataset and classification of political regime, Deininger and Squire (1998) provide evidence that inequality is harmful to growth only for dictatorships. Some other studies, such as Alesina and Rodrick (1994) and Clarke

(1995), find that the effects of inequality on economic growth are negative and statistically significant for democracies as well as for dictatorships.[1]

Overall, the evidence of a systematic difference in the relationship between inequality and growth across different kinds of regimes is, at best, mixed. One reason for such variation in these studies is concerned with measurement error problems. As shown by Weed (1997) and Knack and Keefer (1997), the differential impact of inequality across political regimes found by Persson and Tabellini is entirely driven by measurement error of income distribution and political regime classification. However, poor quality data of income distribution is unlikely to be confined to this study. The income inequality dataset used by Deininger and Squire (1998), which is an improvement over the data used by Alesina and Rodrick (1994) and Clarke (1995), still suffers from serious problems of comparability across countries (Atkisnon and Brandolini, 2001).

Further important reasons for such variety in empirical findings are methodological and econometric difficulties. First, cross-country regressions do not control for unobserved country-level effects. If such effects are correlated with explanatory variables, as is likely in large sample of countries, the coefficient estimates are biased. Second, pure cross-sectional analyses are unable to exploit any piece of information available in the time-series dimension of the data. Third, all these studies have tested the relationship between inequality and growth using a standard linear growth model. However, some later researchers, such as Barro (2000; 2008), Lin *et al*. (2009) and Castelló (2010), find that income inequality is harmful for growth in poorer countries and insignificant, or even beneficial, in richer countries. In light of such evidence, failing to allow for asymmetric effects of income inequality across different levels of income might yield misleading results.

This study overcomes some of the problems reported in the previous empirical literature in three ways. First, I use data on inequality from the University of Texas Inequality Project (UTIP). Unlike the Deininger and Squire (1996) dataset, the measure of income inequality provided by UTIP is comparable and consistent across both years and countries. Its coverage of countries is wide and it has a substantially greater number of

[1] It should be noted that the main focus of Deininger and Squire (1998) is inequality in land distribution. However, they include income inequality in their set of explanatory variables.

year-observations than in any prior dataset. Second, I estimate a growth regression using a two-step system GMM estimator, which allows one to address the dynamics associated with panel data. This methodology also effectively controls for country-specific time-invariant effects. Finally, in the spirit of Barro (2000; 2008) I use an interaction term between the level of income and the inequality variable to allow for a differential impact of inequality on growth depending on income levels. To classify political regime I use the index developed by Cheibub *et al*. (2010), which is constructed based on well-defined classification rules and operational definitions.

The findings of this chapter can be summarized as follows. The results show that the effects of income inequality on growth are negative and statistically significant regardless of the type of political regime. When the level of income is interacted with inequality, the results show that while the overall impact of inequality on growth is negative for relatively low levels of income, it turns out to be positive at higher levels of income. Further, I observe that such a differential effect of inequality on growth across different levels of income is not the same across political regimes. Specifically, the elasticity estimates suggest that income inequality has an economically stronger impact on growth under dictatorships than under democracies.

Admittedly, as this study uses five-year frequency data rather than relying on pure cross-sectional observations, my results cannot be compared directly to those reported in previous analyses on the comparative strength of the inequality-growth relationship across different political regimes.[2] I preferred a longitudinal approach to a cross-section analysis for the methodological reasons which have been explained above. Still, I believe that this chapter provides some relevant insights into the debate over the relative economic performance of different political regimes by reassessing whether the effect of inequality vary across democracy and dictatorships in the light of new and more reliable data, a dynamic model, and sophisticated panel techniques.

The rest of the chapter is organized as follows. Section 2 illustrates the theoretical reasons underlying the impact of inequality on growth as well as the empirical studies

[2] Standard cross-country regression estimates a long-run relationship by assessing the impact of initial levels of inequality on subsequent growth spanning 20 years or more. On the other hand, as my analysis is based on five-year intervals, the estimated coefficients reflect a medium-run relationship.

of the relative strength of the impact across democracies and dictatorships. Section 3 deals with the model and Section 4 describes the data. Section 5 displays the empirical findings of the analysis. Finally, section 6 presents some concluding remarks on the debate over the relative economic performance of alternative political regimes.

2.2. Literature Review

In this section I discuss alternative views regarding the relationship between income inequality and economic growth and present the summary of prior empirical evidence. It turns out that there are several potential mechanisms, such as the level of saving and the state of social unrest, through which income inequality may affect the rate of growth of the economy, at least during a transition toward the new steady state.

2.2.1. Positive effects of income inequality on economic growth

Several theoretical studies have posited that there is a positive relationship between income inequality and economic growth. Such a relationship is based mainly on three arguments: differences in saving propensity between rich and poor, trade-off between equity and efficiency and incentive mechanisms to work effort and innovation.

Theory 1

According to the adherents of the classical view, the marginal propensity to save is higher for wealthy individuals as compared to individuals belonging to lower income classes (Lewis, 1954; Kaldor, 1957). If all savings turn into physical investment, an unequal distribution of wealth is conducive to intensive accumulation of capital, which sequentially accelerates the process of economic growth. In such scenario, any redistribution of wealth from high to low-saving propensity agents would lower capital accumulation, hence the rate of economic growth. Bourguignon (1981) establishes a formal theoretical base of this approach in a neo-classical growth framework. He shows that under the assumption of convex savings function the overall level of output is conditioned by the initial distribution of wealth and that an increase in inequality would lead the economy toward a higher steady-state level. A model combining a convex

saving function with an AK production function predicts that less equalitarian societies will have higher growth rate (Aghion *et al*. 1999).

Theory 2

A positive impact of income inequality on economic growth can also be explained through the trade-off between equity and efficiency (Okun, 1975). According to the second theorem of welfare theory, any Pareto-efficient allocation of resources can be achieved through a suitable lump-sum transfer. If such type of transfer were feasible, distribution of wealth and growth would be independent with each other. However, as lump-sum taxation is unfeasible in the real world, any redistribution necessarily entails a loss in efficiency because it modifies the price system generated by the market. Specifically, by lowering the extent to which an individual can appropriate the return of her investment, higher taxation lessens the incentive to accumulate capital. Thus, if the social outcome generated by markets is viewed as "unfair", the policy maker is faced with a trade-off between a more equitable income distribution and faster growth. As pointed by Okun, the equity/efficiency trade off "plagues us in dozens of dimensions of social policy" (Okun, 1975, p. 2).

Theory 3

An additional reason why income-equalizing transfers lower growth refers to the instrumental role played by inequality in promoting important factors, such as entrepreneurship, innovation and work effort (Siebert, 1998). For example, in a principal-agent setting it is reasonable to assume that the productivity depend on an *unobservable* workers' effort. Levelling wages differentials regardless of the observable level of output is likely to discourage the worker from making any effort (Bell and Freeman, 2001). Another example for the positive relationship between inequality and growth is based on incentive to invest in an economy made by individuals who differ in their inner abilities (Galor and Tsiddon, 1997; Hassler and Rodríguez-Mora, 2000). In this scenario technological innovations raise the return to inner skills relatively to the return to parental background, thereby increasing intergenerational mobility. However, the ensuing concentration of high-skilled workers in the advanced sector concentration might widen the income disparities within each generation.

2.2.2. Negative effect of income inequality on economic growth

Several theoretical works have challenged the existence of a positive relationship between income inequality and economic growth. According to such literature equality in wealth distribution is an important factor for the economy to embark on a sustained growth path. There are at least three mechanisms which accounts for a negative impact of inequality on growth.

Theory 1

A number of studies have focused on the importance of social cohesion in shaping institutional quality (e.g. Easterly, 2001; Keefer and Knack, 2002). According to this genre of studies income inequality is likely to widen social division at the expense of the quality of institutions such as security of contractual and property rights. For example, high levels of income inequality are likely to provide grounds to individuals to take part in detrimental actions like revolts, protests, assassinations and mass violence (Alesina and Perotti 1996; Gupta, 1990). Additionally, the growing unequal distribution of wealth encourages the rich to undertake predatory practices at the expense of the poor, which have a detrimental impact on the security of property rights (Glaeser *et al*. 2003). These kinds of instabilities tend to produce uncertainties concerning the soundness of political and legal environment, which results in a deterioration of the accumulation of physical capital. Since investment is of crucial importance for economic growth, higher wealth inequality would have a negative impact on the overall growth of the economy.

Theory 2

According to the joint schooling/fertility approach of Becker *et al*. (1990), fertility and educational decisions arise as the outcome of an assessment of the return of human capital investments and the return from having offspring. A rise in the wage rate has two contrasting effects: an income effect which increases the demand for children and a substitution effect which affects the demand in the opposite direction because of the increasing opportunity cost of having children. Under the assumption that the return to investment in education is increasing in the stock of human capital, the substitution

effect turns to dominate the income effect at sufficiently high level of human capital. Thus, an increase in income will result in higher investment in human capital and lower fertility. Perotti (1996) has extended this model to a framework in which wealth distribution affects the fertility rate. If fertility is positively correlated with inequality, more egalitarian countries will invest more in human capital, and consequently grow faster.

Theory 3

Another strand of literature has focused on the link between credit market imperfections, distribution of wealth and investment levels (e.g. Galor and Zeira, 1993; Aghion and Bolton, 1992; Banerjee and Newman, 1993). In an economy where human and physical investments are indivisible, individuals with low levels of income need to borrow money in order to finance their investment projects. However, under imperfect and costly information, agents who cannot provide assets as collateral for the loan are prevented from obtaining credit (Stiglitz and Weiss, 1981). This implies that the individuals' economic opportunities depend on their parental wealth, not on their abilities. A talented child from a poor household will not be sent to school. Similarly, a potential but poor entrepreneur will remain a low paid worker. Thus, high levels of wealth inequality mean that a larger fraction of population is unable to undertake profitable investments, thereby decreasing the overall efficiency of the economy.

2.2.3. The effects of income inequality on growth conditional on political regimes

An additional explanation of why wealth inequality might have a negative impact on growth is based on the endogenous redistribution model formalized by Meltzer and Richard (1981). In its simplest version, the model illustrates the political equilibrium within a context where the selection of a linear tax rate- which defines the amount of income being redistributed - is left to a public-decision making process. Here, the level of taxation crucially depends on the income of the *decisive voter* relative to the mean income. Specifically, the higher the mean income relative to the decisive voter's income, the higher is her preferred tax rate. The decisive voter in a democracy is the individual endowed with the median income. Since the median income is generally low

as compared to the income of a monarch or a dictator, universal suffrage is expected to lower the income of the decisive voter, thereby increasing the level of taxation.

Alesina and Rodrik (1994) and Persson and Tabellini (1994) add an additional "economic" channel to the "political" channel envisaged by Meltzer and Richard (1981).[3] This economic channel links the level of redistribution to the rate of growth. Specifically, redistribution and growth are predicted to be negatively related because a higher tax rate is likely to discourage investment. The combination of the political and economic channels provides a mechanism at work in democracies which links inequality to growth: higher levels of income inequality foster policies aimed at redistributing wealth, which in turn lower the growth rate. On the other hand, a similar relationship does not necessarily manifest in dictatorships. In Persson and Tabellini's words "in these countries there may be little relationship between income inequality in the population at large and the redistributive preference of government" (Persson and Tabellini, 1994, p. 612). This line of reasoning predicts the impact of income inequality on growth to be conditional on the political regime. Specifically, one would expect an uneven distribution of income to lower growth in democracies, but not in dictatorships.

2.2.4. Empirical Evidence

The empirical findings on whether income inequality affects economic growth differently across democracy and dictatorship are inconclusive. In this subsection I summarize those empirical studies that have focused on this issue.

Persson and Tabellini (1994) analyse the effects of income inequality on growth for a sample of about 49 countries between 1960 and 1985. As a measure for income distribution they use the income share held by the third richer quintile.[4] Using ordinary least squares, they found that the negative impact of inequality is statistically significant for the sample of democratic countries while it turns out to be insignificant for non-

[3] The main difference between Alesina and Rodrik (1994) and Persson and Tabellini (1994) is that the former allow for some kind of productive public expenditure while the latter focuses exclusively on redistributive policies. Thus, unlike Persson and Tabellini, the level of taxation which maximizes the growth rate is positive in Alesina and Rodrik.

[4] This measure is a proxy for income *equality*. In their analysis the positive sign of the corresponding coefficient indicates an adverse effect of inequality on growth.

democracies. Furthermore, employing a two-stage least square procedure they show that inequality affects growth via investment, and this effect is only present in democracies.

Alesina and Rodrik (1994) study the relationship between inequality and growth for a panel of about 70 countries. They use the Gini index for both income and land as proxies for distribution of wealth. Their results generally show that wealth inequality is deleterious for economic growth. In contrast to the findings of Persson and Tabellini (1994) which indicate that inequality is harmful only for democracies, Alesina and Rodrik find that the effects of inequality on economic growth are negative and statistically significant for democracies as well as dictatorships.

Clarke (1995) runs a growth regression for a large panel of countries using the Theil index and the Gini coefficient as measures of inequality. His findings indicate a negative effect of inequality on growth. Using data for the period 1970-1988, Clarke provides no evidence that the economic impact of inequality varies across different political regimes. However, when he re-estimates the model on an extended set of data spanning 1960 to 1988, he finds some weak evidence in support of the differential effect of income inequality on growth conditional on political regimes.

Perotti (1996) investigates the relationship between income inequality and growth for a panel of about 60 countries covering the period 1960-1985. Specifically, he examines whether the effect of inequality differs across democratic and non-democratic countries. To that end, he uses an interaction term between a measure of income equality and a dummy for democracy. The OLS estimations for the full sample show that there is a negative relationship between income inequality and growth. While the coefficient estimate for the interaction term is positive, it is not statistically significant indicating that there is no differential effect of income inequality across political regimes.

Deininger and Squire (1998) analyze the effect of income inequality on growth using income distribution data from Deininger and Squire (1996), which provides a suitable dataset for panel technique estimations. They find that initial inequality affects subsequent growth in dictatorial countries, while the relationship turns statistically insignificant for the sample of democratic countries. This result stands in stark contrast to the findings of Persson and Tabellini (1994) that indicate that the negative effect of

inequality is statistically significant in democracies only. Some other studies such as Knack and Keefer (1997) and Weede (1997) also argue against Persson and Tabellini's findings on the basis of unreliability of inequality dataset and the political regime classification used in their work.

2.3. The Model

2.3.1. Theoretical Framework

This chapter provides an important theoretical contribution to the median voter model. Specifically, I theorize that the relative strength of the effect of inequality on growth across democracies and dictatorships varies with the country's income level. In this subsection I proceed to explains in details the underlying theoretical context.

The economic channel of the "political-economic model" illustrated above is based on the assumption of perfect credit markets. Under this assumption the individual's economic opportunities are shaped exclusively by her abilities, not by her parental wealth. In such circumstances, a non-lump sum redistribution of income necessarily lowers the growth rate because of the adverse impact that taxation has on investment. However, credit markets are far from working perfectly in the real world. In presence of credit imperfection, markets do not lend to individuals who lack collateral, however high the rate of return on their investment opportunities. Hence, fiscal policies could be used as a means to allow poor endowed households to undertake their investment projects. If the ensuing gain in efficiency exceeds the loss associated with the disincentive effect of taxation, then the overall impact of redistribution on growth would be positive.

Under this scenario, the differential impact of inequality on growth across political regimes pointed by the political-economic model is no longer straightforward. In line with Persson and Tabellini (1994), let us maintain the assumption that democracies pay more attention to distributional issues than dictatorships. Once the hypothesis of perfect-functioning capital markets is abandoned, the negative growth effects of inequality will not necessarily be stronger in democracies. In fact, such negative effect might be even weaker in democracies if fiscal policies are used to foster poor

households' investments. An additional reason of why the adverse impact of inequality on growth could be less serious in democratic countries is concerned with social peace. Fiscal policies which take the form of income-equalizing transfers and other welfare mechanisms raise the opportunity costs for the poor in taking part in disruptive activities (Sala-I-Martin, 1996). Therefore, redistributing wealth from the rich to the poor could prevent the occurrence of social unrest along with its negative consequences on growth rate.

Whether democracy mitigates or exacerbates the negative effect of inequality probably depends on the country's stage of development. As suggested by Barro (2000), it is likely that market imperfections are particularly serious in poor countries due to the absence of a developed financial sector which ameliorates the problem of asymmetric information. For this reason, I believe that in low-income economies democratic regimes could play an important role in tempering the adverse impact of uneven distribution of wealth. On the other hand, it is reasonable that in high-income countries credit markets do a better job in addressing asymmetric information which underlies credit imperfections. Further, social instability is of less concern in the presence of a wealthy middle class, which typically characterizes richer countries. Thus, there would be less for scope for efficiency improving redistribution policies in relatively rich economies.

To conclude, if democracies are (generally) more sensitive to distributional issues than dictatorships, one would expect the negative impact of inequality in low-income countries to be less strong in democracies than in dictatorships. On the other hand, the differential impact across political regimes in relatively rich countries is ambiguous. I investigate this pattern by using the empirical model illustrated below.

2.3.2. Empirical Model

Several empirical studies have relied on longitudinal approach when testing the inequality and growth relationship (e.g. Forbes, 2000; Banerjee and Duflo, 2003; Voitchovsky, 2005; Castelló, 2010). I draw upon such studies to extend the empirical analysis to the investigation of the differential effect of income inequality on growth

across political regimes. Specifically, I estimate a growth equation in the following dynamic framework:

$$Growth_{i,t} = \beta_0 + \beta_1 Income_{i,t-1} + \beta_2 Inequality_{i,t-1} + X_{i,t-1}\Psi + \psi_i + \varepsilon_{i,t} \quad (1)$$

where subscript i represents country and t represents time period. $Growth_{i,t}$ is measured as the 5-year average growth rate of per capita GDP for country i (the time frequency of the data is five-year). Explanatory variables are all measured at the end of the five-year period. For example, this means that the average growth over the five year period between 1981 and 1985 is regressed on the explanatory variables measured in 1980.[5] This lag structure also reduces the potential of reverse causation from growth to inequality as pointed by some studies, such as Lunberg and Squire (2003) and Garcia-Penalosa and Turnovsky (2006; 2007). $Inequality_{i,t-1}$, my main variable of interest, is a measure of income inequality for country i during period $t-1$. ψ_i is a vector of country-specific time-invariant factors and $\varepsilon_{i,t}$ represents the error term. $Income_{i,t-1}$ is the level of income and $X_{i,t-1}$ is a vector of explanatory variables, which includes public spending, inflation, openness and secondary school enrolment for country i during period $t-1$. The selection of these control variables is based on previous theoretical and empirical studies in the growth literature:

1) The (lagged) level of per capita GDP is included because one of the basic tenets of economic theory, the "conditional convergence", points that low-income economies grow faster than high-income economies (other conditions held constant) due to capital flow from richer to poorer countries and technological catch-up (Barro and Sala-I-Martin, 2004).
2) The inclusion of public spending, measured as a share of per capita GDP, is suggested by a large body of literature that has pinpointed fiscal policy as a strong predictor of the growth rate (Landau, 1983; Barro, 1991; Barro and Sala-I-Martin, 2004). The expected sign is ambiguous since a higher share of public spending

[5] If an explanatory variable is not available in 1980 then the value of that variable is taken from the preceding year closest to 1980.

might increase or decrease the growth rate depending on some factors, such as the composition of the spending and fiscal budget positions (e.g. Gupta *et al*. 2002).[6]

3) Inflation, calculated as the change in the consumer price index, is included to control for macroeconomic instability. This is expected to have a negative sign on growth because of the costs associated with inflation, such as "shoe leather' costs", "menu costs" and inefficient allocation of resources due to misperceptions of changes in relative price (Briault, 1995).
4) Openness, defined as the sum of export and import as a share of GDP, is included as a proxy for trade policy. In general, an economy benefits from international trade by exploiting comparative advantages with the result to achieve a higher steady-state level of income. International trade also encourages internal competition, facilitates the flow of technological innovations between countries and provides entry to wider market (Grossman and Helpman, 1991).[7]
5) The inclusion of school enrolment is based on theories which emphasize the role played by human capital in the process of economic growth. According to these theories, human capital raises the productivity of labour, fosters the economy's capacity to innovate and facilitates the adoption of technology from leading countries (Nelson and Phelps, 1966; Romer, 1991). Thus, the coefficient of school is expected to be positive.

Following Persson and Tabellini (1994), Alesina and Rodrick (1994) and Perotti (1996), I do not include investment because many of the theories linking inequality to growth work through the accumulation of physical capital. As regards the political-economic model, one should ideally run two structural equations that estimate the linkage between taxation and investment rate, on the one hand, and the linkage between investment and economic growth, on the other hand. However, computing such a structural model would have drastically reduced the size of the panel because of the limited data availability on taxation. I include the investment variable as a robustness check of the empirical results.

[6] To properly assess the impact of fiscal policy one should use disaggregated measures of public expenditures along with a variable gauging the countries' fiscal budgetary positions. I have relied on an aggregate measure of the overall size of government for reasons of data availability.

[7] Admittedly, this measure is a very imperfect proxy of the extent to which an economy is open to international trade. I use this variable for its extensive coverage of countries and time periods.

$\beta_0, \beta_1, \beta_2$ and Ψ denote the parameters of interest that are estimated. A negative sign of β_1 supports the empirical literature on conditional convergence. The nature of the effect of income inequality on growth is revealed by the sign of β_2. A negative coefficient provides evidence in favour of an adverse effect of inequality on economic growth. Conversely, a positive coefficient implies that higher levels of inequality are conducive to higher rates of growth.

2.3.3. The Role of the Level of Income in the Inequality-Growth Relationship

The model as described in Equation (1) assumes a linear relationship between inequality and growth. However, as discussed in section 2.3.1, the country's stage of development might play an important role in shaping the relative strength of the inequality-growth nexus across political regimes. In addition, a number of studies, such as Barro (2000), Lin *et al*. (2009) and Castelló (2010), have provided evidence that the growth effect of inequality is different across high and low-income economies.[8] Therefore, to investigate this issue, I augment the empirical model by incorporating an interaction term between inequality and the level of income. Specifically, the augmented version of Equation (1) takes the following form:

$$Growth_{i,t} = \beta_1 Income_{i,t-1} + \beta_2 Inequality_{i,t-1} + \beta_3 \left(Inequality_{i,t-1} \times Income_{i,t-1}\right) + X_{i,t-1}\Psi + \psi_i + \varepsilon_{i,t} \quad (2)$$

where $Inequality_{i,t-1} \times Income_{i,t-1}$ is an interaction term between the income inequality measure and the income variable for country i during period $t-1$ and β_3 is a parameter associated with the interaction term. Whether the level of income weakens or strengthens the impact of income inequality on economic growth depends on the sign and the statistical significance of β_2 and β_3. In particular, if both β_2 and β_3 estimates have the same sign and appear statistically significant then the level of income would amplify the effects of inequality on economic growth. On the other hand, if both

[8] Unlike my empirical investigation, these studies do not focus on the differential effect of inequality across democracy and dictatorship.

estimates enter into the model with opposite signs then a rise in income level would reduce the total effect of income inequality on growth.

The inclusion of the interaction term enables us to compare the sensitivity of economic growth to income inequality across political regimes at different income levels. Specifically, I asses the elasticity of growth by using the following expression:

$$\frac{\partial Growth_{i,t}}{\partial Inequality_{i,t-1}} = \hat{\beta}_2 + \hat{\beta}_3 \times Income^* \qquad (3)$$

where $\hat{\beta}_2$ and $\hat{\beta}_3$ are the estimated coefficients of income inequality and the interaction term from Equation (2), respectively. *Income** is the particular level of income. Specifically, I calculate the sensitivity at 10th, 25th, 50th, 75th, 80th and 90th percentiles of the underlying income variable.

Before concluding this section, it is important to call the reader's attention to an important issue. My work is indirectly related to the literature on the so-called Kuznets curve whereby income inequality first increases and then decreases with the level of development. However, the Kuznets hypothesis is concerned with the issue of how the level of income shapes the distribution of income. On the other hand, my work deals with the issue of how the distribution of income affects the rate of growth (not the level of income). Therefore, not only the direction of causation, but also the variables under analysis are different.

2.3.4. Estimation Method

In a dynamic model such as given in Equation (2) the dependent variable depends on its values in previous periods.[9] Thus, OLS estimation yields inconsistent estimates as the lagged dependent variable causes the fixed effects ψ_i to be correlated with the set of

[9] This can be easily seen when the growth variable in Equation (2), is expressed in terms of first differences of income levels, and then the lagged income term is added to both sides. Setting $\alpha_1 = \beta_1 + 1$, Equation (2) can be rewritten as follows:

$$Income_{i,t} = \alpha_1 Income_{i,t-1} + \beta_2 Inequality_{i,t-1} + \beta_3 \left(Inequality_{i,t-1} \times Income_{i,t-1} \right) + X_{i,t-1}\Psi + \psi_i + \varepsilon_{i,t}$$

right hand side variables (see, for example, Beck *et al*., 2000). Within estimator is also inconsistent because the lagged dependent variable is correlated with the error term (Nickell, 1981).

To correct for the bias introduced by the lagged dependent variable, some researchers have utilized the first-difference GMM estimator developed by Arellano and Bond (1991). Specifically, such a technique removes the fixed effects by taking the first difference of the underlying variables in the model and uses their lagged values as IV instruments. Although this difference estimator is designed to deal with the dynamic model, it still suffers from some econometric weakness. First, differencing drops valuable pieces of information from variability across country. Secondly, differencing intensifies the bias from measurement errors (Griliches and Hausman, 1986). Finally, the difference GMM estimator suffers from a "weak" instruments problem when the variables are persistent over time (Blundell and Bond, 1998).

Arellano and Bover (1995) provide a solution for these problems by elaborating the system GMM estimator later fully developed by Blundell and Bond (1998). Specifically, the model depicted in Equation (2) can be estimated as a system of dynamic equations as follows:

$$\Delta Growth_{i,t} = \tilde{\beta}_1 \Delta Income_{i,t-1} + \tilde{\beta}_2 \Delta Inequality_{i,t-1} + \tilde{\beta}_3 \Delta\left(Inequality_{i,t-1} \times Income_{i,t-1}\right) + \Delta X_{i,t-1}\tilde{\Psi} + \Delta\tilde{\varepsilon}_{i,t} \quad (4)$$

$$Growth_{i,t} = \beta_1 Income_{i,t-1} + \beta_2 Inequality_{i,t-1} + \beta_3\left(Inequality_{i,t-1} \times Income_{i,t-1}\right) + X_{i,t-1}\Psi + \psi_i + \varepsilon_{i,t} \quad (5)$$

While the difference estimator only considers the Equation in difference (4), the system GMM technique estimates both Equations (4) and (5) simultaneously. As a result of using additional moment conditions from (5), the system GMM estimator yields more efficiency than the difference estimator and it effectively controls for the problem of weak instruments.

To test the validity of the instruments used in the system GMM estimation, I employ the J test for overidentifying restrictions developed by Hansen (1982). The consistency of the GMM estimator depends on the additional assumption of no second-order serial correlation in the error $\varepsilon_{i,t}$. For this purpose, I use the Arellano and Bond (1991) test to check the presence of serial correlation. If both tests fail to reject their respective null hypotheses, then one can be reasonably confident that the system GMM is delivering valid estimates.

2.4. Data and Variable Definitions

2.4.1. The Sample

This study is based on an unbalanced panel of 88 countries covering the period spanning 1970 to 2005. The sample consists of countries which have different levels of economic development, geographical backgrounds and other country-specific characteristics. The sample is restricted to include only countries that have data for at least three consecutive periods.

The datasets for regression analysis consists of up to seven non-overlapping sub-periods with five-year intervals. The 5-year frequency allows us to compare the results with relatively recent empirical studies, such as Forbes (2000), Lin *et al*. (2009) and Castelló (2010), who have used a similar dynamic framework. Since annual growth tends to reflect short-run fluctuations, the dependent variable is included as sub-periods average.

The list of sample countries with their respective political regime is given in Table A.1 in Appendix. As it can be seen the majority of the sample countries did not switch their political regime. Of the 88 countries included in the underlying sample, 28 of them have experienced at least one transition between dictatorship and democracy. The majority of changes are from dictatorship to democracy. In my panel any country-observation for a given sub-period is recorded as either democracy or dictatorship according to the classification of its political regime in the last year of that specific sub-period. For example, on the basis of Alvarez *et al*. (1996) classification rules, Indonesia had a transition toward democracy in 1999. Within the 5-year structure of my data, Indonesia

is recorded as dictatorship for the sub-periods 1981-1985, 1986-1990 and 1991-1995 and as a democracy for 1996-2000 and 2001-2005.

2.4.2. Variable Definitions and Data Sources

Although the main purpose of this study is to examine the relationship between income inequality and economic growth across different political regimes, I include an additional set of variables to control for other conventional determinants of economic growth. A detailed discussion of the construction of the income inequality measure and the democracy index is given in the following subsections. Further details on variables and data sources are given in Table A.2 (Appendix).

Democracy

Since this study is aimed at analysing differential effects across democracies and dictatorships, I rely on a categorical index of political regime. Specifically, I use the index of democracy developed by Cheibub *et al*. (2010).[10] This index is an extension, in terms of both time and coverage of countries, of the one published in Alvarez *et al*. (1996). Cheibub *et al*. (2010) define political regimes based on the definition given in Alvarez *et al*. (1996). In particular, a regime is defined as democratic unless any of the following conditions is violated:

1) The chief executive is chosen directly or indirectly by popular election.
2) The legislature is selected by general elections.
3) There are two parties at least which stand for the election.

Based on these three rules Alvarez *et al*. (1996) construct a binary variable for a large sample of countries between 1950 and 1990, which takes the value 1 if the country is classified as democratic and 0 if the country is classified as a dictatorship. Cheibub *et al*. (2010) provide an updated series covering the 1950-2010 period.

[10] This index has been used, among others, by Papaioannou and Siourounis (2008) to construct their dataset of political transitions.

I preferred such index of political regime to a discrete transformation of a continuous ranking, such as Polity IV and Freedom House, for two reasons. First, there are several conceptual and methodological problems with continuous indices of democracy (see, for example, Gleditsch and Ward, 1997; Przeworski *et al*., 2000; Munck and Verkuilen, 2002). Second, when dichotomising a continuous index there is no prior theoretical reason to choose among different cut-offs (Cheibub *et al*., 2010).

Income Inequality

The absence of data on the distribution of wealth for a sufficient number of countries forces researchers to use proxies in empirical investigation. The most common approach is to use data on income inequality as a proxy for wealth inequality.[11] However, sources and methods are often heterogeneous not only across countries but also over time within a given country. In an attempt to overcome these problems, Deininger and Squire (1996) have constructed a dataset (hereafter DS) on income distribution with the specific purpose of allowing systematic analyses across countries and over time. Specifically, Deininger and Squire have started from a dataset of more than 2,600 observations collected from a large variety of previous studies. Then they have proceeded to drop any observation which does not meet the following three criteria: (i) the source of information is the household survey; (ii) the survey must have national coverage; (iii) the information is drawn from a variety of income sources (or expenditure), such as wage, pensions and self-employment earning. The authors end up with a "high quality" dataset made of 682 observations.[12] This dataset improves over previous data on income distribution in two ways. First, the number of high quality observations is considerably larger in the DS dataset than in other datasets. Second, the coverage of countries provided by the DS is much wider than alternative datasets.

For these reasons, the DS dataset used by Deininger and Squire (1998) is more reliable than alternative dataset used by previous studies on the differential effect of inequality on growth across political regimes. Specifically, Paukert (1973) - the dataset on income inequality used by Persson and Tabellini (1994) – has several observations which do not

[11] Alternatively, one may proxy the distribution of wealth by using the information on the distribution of land (see, for example, Deininger and Squire, 1998).
[12] A large number of studies, such as Forbes (2000), Banerjee and Duflo (2003) and Castelló (2010), have relied on the DS dataset to assess the impact of income inequality on economic growth.

meet the criteria underlying the DS dataset. [13] Field (1989) and Jain (1975) - the datasets used in Alesina and Rodrik (1994) and Perotti (1996) - improve over Paukert, yet they include several observations whose value is quite different from the corresponding observations in the DS dataset (Deininger and Squire, 1996).[14]

Although the DS dataset provides a more reliable basis for empirical investigation, serious problems remain. First, the coverage varies substantially across countries and over time. While for some countries, such as the United States and the United Kingdom, the dataset provides observations for almost every year, data on other countries, especially in Africa and Latin America, are sparse and highly unbalanced. Thus, any study based on the DS dataset fails to effectively represent those countries which have no surveys on a regular basis (Galbraith and Kum, 2003). Second, as discussed by Atkinson and Brandolini (2001), there are differences in definitions of variables which make the DS dataset ill-suited for cross-country analysis. Specifically, while some observations are based on income others are based on expenditure. This is problematic because, as acknowledged by Deininger and Squire (1996), inequality in expenditure tends to be less skewed than inequality in income. To account for this difference Deininger and Squire suggest adding 6.6 to expenditure-based Gini measures to make them comparable with income based measured (6.6 being the average difference between the two types of measures). However, as pointed by Atkinson and Brandolini (2001) it is doubtful "whether a simple additional or multiplicative adjustment is a satisfactory solution to the heterogeneity of the available statistics" (p. 790). In addition, there are further differences in definition concerning the recipient unit (household or individual) and the use of gross and net income. Finally, there are dubious cases even in variation over time within the same country. According to the DS dataset, there are several countries which experienced a variation in the Gini index by 5 or more points in just one year. It is puzzling that the distribution of income in a country could really change so dramatically in such short time, unless during time of social upheavals (Galbraith and Kum, 2003).

[13] Weede (1997) and Knack and Keefer (1997) use the same dataset as Persson and Tabellini (1994), namely Paukert (1973). As explained above, their investigations are aimed to show that Persson and Tabellini findings are driven by measurement error.

[14] I am unable to make any assessment on the inequality data used by Clarke (1995), because the author does not report the source of the dataset.

Taking into account these considerations, Galbraith and Kum (2005) have made an attempt to construct an alternative, more reliable, dataset on income inequality. To start with, they have constructed a dataset on pay inequality from the data collected by the United Nations Industrial Development Organization (UNIDO). This dataset - compiled for the University of Texas Inequality Project (UTIP) and known as the UTIP-UNIDO dataset- is based on the between-group component of the Theil's statistics, which is a measure of manufacturing pay dispersions across industrial categories.[15] This measure obviously embraces a narrower concept of inequality than the DS measure based on household income inequality. On the other hand, the UTIP-UNIDO measure of manufacturing pay inequality is based on a unique accounting framework - the 3-digit code of the International Standard Industrial Classification (ISIC) – therefore it is more reliable for cross-section and time-series analysis than the DG measure, which is instead based on disparate household surveys. In addition, as explained in Galbraith and Kum (2005), pay is closely related to income inequality because pay accounts for a large share of total income.

Then, Galbraith and Kum have proceeded to estimate an empirical relationship between the DS and the UTIP-UNIDO data set of inequality. They find that the UTIP-UNIDO measure of inequality has a strong explanatory power for the DS measure.[16] Thus, they used the estimate coefficients to produce an income inequality dataset which match each of the observation contained in the UTIP-UNIDO dataset of pay inequality. The idea underlying this imputed dataset – which the authors label as the Estimated Household Income Inequality (EHII) Data Set - is to keep the reliable pieces of information from the DS dataset, while avoiding the afore-mentioned problems. The EHII measure of inequality varies from 0 (perfectly equal distribution of income) to 100 (only one person holds total income of the society).[17] This dataset improves on the DS data in several ways. First, it provides a total number of observations above 3,000 against the 682 observations contained in the DS data, which makes the EHII dataset less at risk of sample selection bias. Second, the EHII measure is more precise than the DS measure because it exploits additional pieces of information from the UTIP-UNIDO measure.

[15] See Conceição and Galbraith (1998) for more details on the Theil's T statistic.
[16] The set of regressors include some additional explanatory variables, such as the ratio of manufacturing employment to population and population growth.
[17] Nel (2006), Daymon and Gimet (2009), Lin and Ali (2009) and Tan and Law (2011), among others, have used the EHII dataset for empirical analysis.

For example, unlike the DS dataset, the EHII measures clearly show that inequality in OECD countries has risen since 1979, which is likely to be what really happened given the advent of the Thatcher/Reagan era. Finally, as the model linking the DS measure to the UTIP-UNIDO measure contains a set of dummy variables for the different definitions of income (e.g. variable taking 1 if the measure is household based and 0 if income based), the EHII estimates effectively address the problems of heterogeneity which plague the DS measures.

2.5. Empirical Findings

2.5.1. Summary Statistics and Correlation Estimates

This subsection presents preliminary statistics illustrating means and standard deviations of the underlying variables for the full sample as well as for the samples of democracies and dictatorships separately. Table 2.1 presents the results. The last column displays a *t*-test on the equality of means across democracies and dictatorships.

The average growth for the democracy sample is 2.07, while the corresponding figure for the dictatorship sample is 1.39. This suggests that, without controlling for any other variable, democratic countries had on average higher economic growth compared to non-democratic countries over the period under investigation. The estimates of standard deviations reveal that the growth rate in democratic countries is also less volatile relative to non-democratic countries. This difference is statistically significant with a *p*-value of 0.042.

With regard to the per capita GDP, the estimated statistics reveal that democratic countries have on average higher levels of income than dictatorships. Democracies are also characterized by higher education levels compared with non-democracies. Dictatorships have on average more public spending (as a percentage of GDP) as compared to democracies. As shown by the *t*-test, differences in the inflation rate and trade openness across political regimes are not statistically significant.

Table 2.1: Summary Statistics for the Main Variables (1970-2005)

Variables	Full Sample	Democracy	Dictatorship	*t*-test (*p*-value)
Growth	1.769	2.070	1.388	0.042
	(3.334)	(2.492)	(4.138)	
Income	8.864	9.405	8.183	0.000
	(1.099)	(0.855)	(0.990)	
Public Spending	17.215	16.159	18.543	0.001
	(7.727)	(5.677)	(9.561)	
Education	64.775	80.973	44.404	0.000
	(33.478)	(28.139)	(28.139)	
Inflation	39.796	29.719	52.469	0.522
	(372.582)	(157.926)	(531.592)	
Openness	70.450	70.058	60.918	0.832
	(43.692)	(46.566)	(39.895)	
Inequality	41.539	39.067	44.647	0.000
	(6.459)	(5.867)	(5.804)	

Notes: The table illustrates the means of the variables used in the analysis (standard deviations in parentheses). The last column reports the *p*-values from the *t*- tests on the equality of means across democracies and dictatorships.

The table also shows that democracies have been more egalitarian than dictatorships in terms of the Gini coefficient. Specifically, the mean value of income inequality for dictatorships is 44.65, which is higher than the mean value for democracies, 39.07. The mean growth has fluctuated between 0.58 (1981-1985) and 3.07 (2001-2005) percentage points while the Gini inequality has oscillated between 39.69 (1976-1980) and 43.31 (2001-2005) (not shown here).

To get preliminary evidence on the relationship between economic growth and other explanatory variables, I estimate correlations for the full sample as well as for each of the democracy and dictatorship samples. Table 2.2 presents the correlations.

The table reveals that the economic growth rate is positively correlated with the level of income, education and the proxy for openness. In contrast, the correlation between economic growth and public spending, inflation rate and income inequality is negative in case of the full sample. The unconditional correlation between growth and Gini inequality varies from -0.37 in the (1986-1990) to 0.18 (2001-2005), which is statistically insignificant (not shown here). The signs of the correlations remain unchanged when the sample is split according to the political regime. However, the

coefficients for education, public spending and openness are not statistically significant for dictatorships.

Table 2.2: Correlation Matrix

Variables	Full Sample	Democracy	Dictatorship
Income	0.184	0.201	0.128
	(0.000)	(0.001)	(0.074)
Public Spending	-0.170	-0.336	-0.076
	(0.000)	(0.000)	(0.290)
Education	0.137	0.122	0.086
	(0.004)	(0.055)	(0.230)
Inflation	-0.131	-0.191	-0.121
	(0.006)	(0.002)	(0.091)
Openness	0.134	0.205	0.087
	(0.005)	(0.001)	(0.225)
Inequality	-0.160	-0.138	-0.131
	(0.001)	(0.030)	(0.066)

Notes: The table shows simple correlations between economic growth and explanatory variables (*p*-values in parentheses).

2.5.2. Estimation Results

I start the empirical investigation by estimating a standard dynamic growth model for the full sample without the interaction term between per capita GDP and the Gini index. The estimation results are displayed in Panel A of Table 2.3.

Panel B of Table 2.3 presents the *p*-values of the Hansen (1982) test for overidentifying restrictions and the Arellano-Bond (1991) test for serial correlation in the residuals. The number of countries, observations and the number of instruments are shown at the bottom of the table.

Commencing the analysis with the control variables, the results from the baseline model indicate that economic growth is positively related to education and openness, whereas growth is negatively affected by the level of income and public spending. Specifically, I find that the impact of income level on growth is negative and statistically significant, which is consistent with the literature on convergence (Barro and Sala-I-Martin, 2004; Mankiw *et al*., 1992).

Table 2.3: System GMM Estimates for Income Inequality Effect on Economic Growth in Different Groups of Countries

Panel A: Estimation Results			
	Model 1 (Full sample)	**Model 2 (Democracy)**	**Model 3 (Dictatorship)**
$Income_{t-1}$	-1.762***	-1.596***	-1.381**
	(0.404)	(0.431)	(0.549)
$Public\ Spending_{t-1}$	-0.078**	-0.073*	-0.103***
	(0.035)	(0.042)	(0.037)
$Education_{t-1}$	0.062***	0.043***	0.058**
	(0.014)	(0.011)	(0.022)
$Inflation_{t-1}$	0.000***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)
$Openness_{t-1}$	0.017***	0.016***	0.015**
	(0.004)	(0.005)	(0.007)
$Inequality_{t-1}$	-0.089***	-0.095**	-0.115**
	(0.034)	(0.038)	(0.050)
Constant	17.017***	17.474***	15.660***
	(3.572)	(5.033)	(4.049)
Panel B: Diagnostic Tests			
AR(2)	0.763	0.188	0.886
Hansen test	0.483	0.603	0.679
Observations	271	166	105
Countries	88	56	46
Instruments	60	59	29

Notes: The table shows the main determinants of economic growth. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

The coefficient estimate for public spending is also negative and statistically significant, which indicates that the countries with higher levels of public spending are likely to have a relatively low growth rate. This result is in line with a large body of the literature which has corroborated a negative effect of public expenditure on growth (see, for example, Barro, 1991; Barro and Sala-I-Martin, 2004).

The results from Model 1 (full sample) also show that education levels positively affect economic growth. This finding is in line with previous empirical findings by Mankiw *et al*. (1992), Barro (2001) and Barro and Sala-I-Martin (2004). Contrary to the expectations, the inflation variable is statistically significant with a positive sign. Yet, the magnitude of the estimated coefficient is practically zero. Such a result is in line

with Barro and Sala-I-Martin (2004) who also document an economically insignificant impact of lagged inflation on subsequent growth.

Finally, the coefficient of trade openness, measured as the sum of exports and imports to GDP, is positive and statistical significant. This is in line with several studies, such as Yanikkaya (2003) and Lee *et al*. (2004), who also provide evidence for a positive impact of openness on growth.

As for the consistency of the estimator, statistical tests suggest that the assumptions underlying Arellano and Bover's estimators are met. As Panel B of Table 2.3 reveals, the test for second-order serial correlation cannot reject the null hypothesis that the error term is not serially correlated at order 2 and higher orders. Furthermore, the Sargan test of overidentifying restriction does not invalidate the set of instruments used in the estimation.

The Effect on Growth of Income Inequality

As can been seen from Model 1 of Table 2.3, the coefficient estimate for income inequality is negative and statistically significant at the 1% level. This implies that higher levels of income inequality result in a reduction of economic growth. In particular, according to the estimate of the inequality coefficient, a one-standard deviation increase in the measure of income inequality (Gini index) would reduce the growth rate of the economy by a magnitude of around 0.58 percent over the next 5-years.[18]

On theoretical grounds, in addition to the political-economic model, there are other models which can explain such negative relationship. For example, as explained in the literature review, wealth inequality is likely to be harmful for growth because of credit market imperfections which inhibit poor households from obtaining credit to finance their investment projects (Galor and Zeira, 1993; Banerjee and Newman, 1993). Other models point out that economic inequality exacerbates social divisions, thereby

[18] This figure has been obtained as the difference between two fitted values of the growth rate. The first value is obtained by multiplying the estimated coefficient $\hat{\beta}_2$ by the average of the Gini index (41.54). The second value is computed by multiplying $\hat{\beta}_2$ by the sum of the average and standard deviation of the Gini index (41.54+6.46).

undermining investment and economic growth (e.g. Alesina and Perotti, 1996; Easterly, 2001).

On the empirical side, the negative effect of income inequality on growth is in contrast to the findings of Forbes (2000), who shows a positive impact of income inequality on economic growth using a model similar to the one used here. However, as Forbes' analysis relies on the DS dataset on inequality, her estimation is likely to suffer from serious measurement errors. An additional reason underling the contrasting results might lie in differences in sample size and time coverage. The dataset used by Forbes include 45 countries over the years 1966-1995 while my dataset encompasses 88 countries over the time period between 1970 and 2005.

Furthermore, Forbes (2000) uses first difference GMM to address omitted variable bias and endogeneity of the explanatory variables. However, as explained above, the use of such estimators is problematic when applied to time series characterized by a high degree of persistence. This is particularly true for variables like income inequality whose variation is mainly cross-sectional. In fact, the within-country standard deviation of income inequality in my sample is about 2.91, which is almost half of the between-country standard deviation, of about 5.77. On the other hand, system GMM improves over first differences GMM in that it also exploits information from an additional equation in levels (Equation 5).

The Impact of Income Inequality across Democracies and Dictatorships

To examine whether income inequality has a differential impact on growth across different political regimes, I estimate Equation (1) separately for the sample of democracies and dictatorships. The results are shown in Models 2 and Model 3, Table 2.3. As can be seen, the inequality coefficient has a negative sign in both political regimes. Further, the null hypothesis that inequality does not affect growth is rejected at 5% for each set of countries.

I run a Wald test to check whether the estimated coefficients are jointly statistically different across the two political regimes. Specifically, the test statistic is 14.42 (*p*-value: 0.02). Thus, the null hypothesis of equality of coefficients can be rejected at the

5% significance level in favour of the alternative hypothesis that the underlying estimates are statistically different across democracies and non-democracies.

Although the analysis is not directly comparable with previous studies on the relative strength of the inequality-growth nexus across political regimes, it is still interesting to note that my results are consistent with the empirical findings of Alesina and Rodrick (1994), Clarke (1995) and Perotti (1996). On the other hand, these results are in contrast with Persson and Tabellini (1994) which suggest that the effects of income inequality on growth are significant for a sample of democratic countries only. My findings also differ from Deininger and Squire (1998) who document a retarding growth effect of inequality for a sample of dictatorships only.

The other results in Table 2.3 indicate that the effects of country specific determinants of growth such as the income level, education and openness maintain their statistical significance for both political regimes.

The Effect of Inequality across Different Levels of Income

In this section I run the growth regression as specified in Equation (2) to allow for a nonlinear relationship between inequality and growth. Model 1 in Table 2.4 reports the estimation results for the full sample of countries.

The coefficient estimates for both income inequality and the level of income have the expected negative signs and are statistically significant. The estimate on the interaction term between income inequality and the level of income enters into the model with a positive sign and it is statistically significant. These findings suggest that the negative effects of income inequality on growth weaken as income increases. For the sample considered here, the effect of income inequality on growth is negative if (the log of) GDP per capita < 9.20 and positive for higher values for the full sample of countries.

Table 2.4: System GMM Estimates for Income Inequality Effect on Economic Growth in Different Groups of Countries Conditional on the Level of Economic Development

Panel A: Estimation Results			
	Model 1 (Full sample)	**Model 2 (Democracy)**	**Model 3 (Dictatorship)**
$Income_{t-1}$	-7.672***	-4.897***	-10.842**
	(2.270)	(1.569)	(5.112)
$Public\ Spending_{t-1}$	-0.072**	-0.054*	-0.086**
	(0.034)	(0.031)	(0.037)
$Education_{t-1}$	0.059***	0.048***	0.063***
	(0.012)	(0.012)	(0.021)
$Inflation_{t-1}$	0.000***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)
$Openness_{t-1}$	0.012**	0.013**	0.019*
	(0.005)	(0.005)	(0.011)
$Inequality_{t-1}$	-1.335***	-0.746**	-1.657**
	(0.488)	(0.343)	(0.782)
$Income_{t-1}*Inequality_{t-1}$	0.145***	0.079**	0.193**
	(0.051)	(0.036)	(0.093)
Constant	68.928***	44.657***	90.452**
	(22.099)	(15.056)	(41.777)
Panel B: Diagnostic Tests			
AR(2)	0.903	0.167	0.992
Hansen test	0.330	0.600	0.897
Observations	271	166	105
Countries	88	56	46
Instruments	58	45	45

Notes: The table shows the main determinants of economic growth. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Because of the presence of the interaction term, the growth effect of inequality cannot be assessed from the linear term of inequality only. However, as shown in Equation (3), it is possible to examine the sensitivity of growth to income inequality at different income levels. The estimates of elasticity for the case of the full sample are given in Model 1 of Table 2.5 and plotted in Figure 2.1 (in Appendix).

Table 2.5: Elasticity of Growth with respect to Income Inequality across (log) Income Percentiles

Panel A – Model 1 (Full Sample)						
	P10	**P25**	**P50**	**P75**	**P80**	**P90**
Income level	7.463	8.340	9.034	9.888	9.980	10.177
Elasticity	-5.636	-2.841	-0.627	2.093	2.388	3.016
Panel B – Model 2 (Democracy)						
	P10	**P25**	**P50**	**P75**	**P80**	**P90**
Income level	8.106	8.906	9.703	10.038	10.088	10.220
Elasticity	-1.800	-0.738	0.319	0.765	0.831	1.005
Panel C – Model 3 (Dictatorship)						
	P10	**P25**	**P50**	**P75**	**P80**	**P90**
Income level	6.834	7.550	8.394	8.719	8.875	9.228
Elasticity	-12.936	-7.586	-1.279	1.144	2.312	4.949

Notes: The table reports the percentiles of the income level measured in terms of natural log of per capita GDP along with the estimates of the elasticities of growth with respect to income inequality. Panel A reports the elasticities for the full sample. Panels B and C report the elasticities for the sample of democracy and dictatorship.

As can be seen, the elasticity is negative for income percentiles below the median but it turns positive for higher percentiles. These results indicate that whilst for relatively low levels of income the growth dampening aspects of inequality dominate the growth enhancing effects, the opposite occurs at relatively high levels of income. These estimates are in line with Barro (2000), Lin *et al.* (2009) and Castelló (2010) who have found that the growth effect of inequality is different across high and low-income economies.

As already explained in the section on literature review, some previous theoretical works, such as Okun (1975), Bourguignon (1981) and Galor and Tsiddon (1997), have provided some explanations of why inequality might have a positive effect on growth. As for the differential impact of inequality across different levels of income, Barro (2000) points to the endogeneity of credit constraints as a possible explanation underlying such patterns. As discussed in section 2.2.2, a strand of theoretical models predict a negative relationship between inequality and growth due to market imperfections which prevent poor households from running profitable investment (e.g. Galor and Zeira, 1993; Banerjee and Newman, 1993). On the other hand, as a country grows richer, it develops an institutional framework which ameliorates capital market imperfections and, thus, the adverse effect of inequality. As a result, the effect of inequality on economic growth may vary with the country's level of income. Specifically, while for relatively low levels of income the growth dampening aspects of

inequality dominate the growth enhancing effects, the opposite may occur at relatively high levels of income (Barro, 2000).

With regard to the remaining variables, signs and statistical significance are overall preserved (results in Table 2.4 as compared to the results in Table 2.3). Second order correlation and Sargan tests detect no statistical problems associated with the system GMM estimation (Panel B in Table 2.4).

The Differential Effect across Political Regimes Conditional on Income Levels

I now estimate Equation (2) separately for the sample of democracies and dictatorships.[19] The coefficient estimates are given in Model 2 and 3 of Table 2.4 and the corresponding elasticities are given in Panels B and C of Table 2.5. As can been seen, the interaction term is positive and statistically significant for both samples, meaning that the negative effect on inequality weakens regardless of the political regime. The turning points for the sample of democracies and dictatorships are 9.44 (close to the average income of Argentina in 1996-2000) and 8.59 (approximately the average of Panama in 1976-1980), respectively. A comparison of elasticities between political regimes in Table 2.5 reveals that the sensitivity of growth is generally higher for dictatorships than democracies regardless of whether the sensitivity is negative or positive.

To get more visual insight into the sensitivity of growth to inequality across different levels of income, I plot the estimates given in Panel B and C of Table 2.5 in Figure 2.2 (Appendix). The sensitivity of growth exhibits significant differential patterns across political regimes. Specifically, as is clear from Figure 2.2, the sensitivity of growth to income inequality differs across political regimes at the same income quintiles. For percentile of income between 40^{th} and 65^{th}, the elasticity is positive for democracies but negative for dictatorships. As for the remaining percentiles the sensitiveness of growth to inequality is larger under dictatorships than under democracies, irrespective of whether the elasticity attains negative or positive sign.

[19] The Wald statistic for testing the null hypothesis of equality of all coefficients across the two political regimes is 3.67 (*p*-value: 0.00).

Taken together, the estimates of elasticity offer empirical evidence that the effects of inequality vary with the level of income differently for democracies and non-democracies. As far as relatively low-income countries are concerned, the results show that the overall impact of inequality on growth, which is of negative sign, is weaker under democracies than under dictatorships. One possible reason for such differential impact revolves on the beneficial effects of redistributional policies in poor countries. First, redistribution could be used to mitigate liquidity constraints that otherwise prevent poor households from engaging in productive investments. Secondly, by providing a system of social safety nets redistribution might easy political instability and social unrest. The empirical result revealed by the estimates is thus in line with the expectations of my model.[20]

On the other hand, the estimates show that the overall impact of inequality in rich countries, which is of positive sign, is stronger under dictatorships than under democracies. As explained in section 2.3.1, credit market imperfections and social unrest are likely to be of less concern in richer countries. Hence, it is plausible that redistributional policies here do not sort out the same beneficial effects as in poorer countries. Given the disincentive effect on saving and investment of taxation, it might be that fiscal policies turn to be bad for growth at relative high levels of income.[21] This could be one potential explanation of why the overall positive impact of inequality on growth in rich countries is lower under democracies than under dictatorships.

Admittedly, the empirical findings along with the above explanation have to be interpreted with a great deal of caution. First, because of their parsimonious specification, the equations estimated in this chapter cannot test directly the underlying mechanisms linking inequality to growth. Second, the explanation of the differential effect works if (i) higher inequality leads to higher demand for redistribution and (ii) democracies are more sensible to redistributional issues than dictatorships, *on average*.[22] Finally, it is possible that political institutions are endogenous to the

[20] In line with the political model approach, my model assumes that democracies are (generally) more sensitive to distributional issues than dictatorships. This point is further discussed below.

[21] The empirical test of this conjecture requires detailed data on fiscal policy which are currently unavailable for large panel of countries. However, this might be an interesting starting point for future empirical analysis.

[22] Several studies, such as Brown and Hunter (2004), Stasavage (2005) and Avelino *et al*. (2005), find that democracies have relatively high levels of social spending. Other studies, for example, Finseraas

distribution of economic resources (e.g. Acemoglu *et al.*, 2004).[23] Although there is currently no general theory of democratization, the possibility that my empirical findings are driven by some selection mechanisms cannot be ruled out.

2.5.3. Robustness Check

In this section I perform some further estimation to test the robustness of the empirical results. First, I check for the effect of dropping outliers.[24] Specifically, my findings could be driven by few countries with relatively high (low) growth rates. To identify such potential influential observations I use the quartile method whereby a value is defined as an outlier if it is lower than $Q_1 - 1.5H$ or higher than $Q_3 + 1.5H$, Q_1 and Q_3 being the lower and upper quartile, respectively, and H the inter-quartile range (Doane and Seward, 2007, Ch. 4). The results for the sample of democracies and dictatorships are shown in Models 1 and 2 of Table A.3 in Appendix.[25] Interestingly, the coefficient of public spending for the sample of democracies is now statistically insignificant for the sample of democracies. As for the remaining variables, the results are robust in terms of both their statistical significance and sign.[26]

Next, I proceed to identify influential data on the basis of a visual inspection of the residuals. Figures 2.3-2.4 in the Appendix plot the residuals against the fitted values of the dependent variables. The observations concerning the sample of democracies with residuals more than 4 or less than -4 (5 and -5 for dictatorships) are those which are poorly fitted by the model. [27] Thus, it would be interesting to check the robustness of the

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(2009) and Dallinger (2010), provide empirical evidence in favour of a positive relationship between level of inequality and demand for redistribution. However, there is no general agreement among scholars on such issues (see Mulligan *et al.*, 2004; Lübker, 2007).

[23] See also Stiglitz (2012) who argues that excessive concentration of economic power is undermining political institutions in the US.

[24] A variety of statistics has been designed to evaluate influential data. There are two commands in Stata based on the DFITS and DFBETA statistics which provide an automatic detection of outliers (Baum, 2006). Unfortunately, these commands do now work after the estimation with "xtabond2".

[25] The observations classified as outliers for the sample of democracies are Ireland 1996-2000, South Korea 1986-1990 and Trinidad and Tobago 1996-2000. As regards for dictatorships the outliers are Azerbaijan 2001-2005, Cameroon 1986-1990, Jordan 1986-1990, Kuwait 1981-1985, 1986-1990, 2001-2005 and Togo 1981-1985.

[26] As it can be seen from Panel B, the null hypothesis of no second-order serial correlation for the sample of dictatorships is rejected at the 5% but it cannot be rejected at the 10% level of confidence.

[27] With regard to democracies the observations having relatively large residuals are Finland 1991-1995, Ireland 1996-2000, South Korea 1986-1990, Thailand 1986-1990, 1991-1995, Trinidad and Tobacco 1996-2000 and Venezuela 1981-1985. As regards for dictatorships large residuals have been found for

estimates to the removal of these observations. Models 3 and 4 of Table A.3 illustrate the results for each of the sub-samples. It is interesting to note that public spending loses statistical significance for democracies as well as dictatorships. As for the coefficient estimates of the inequality measure and the interaction term, signs and statistically significance are preserved.

I have also used the Hampel method of outlier detection on the regressions' residuals. According to this method an outlier is defined as any observation for which $|x_i - Me| \geq 5.2 mad(\mathbf{x}_n)$, where Me is the median and $mad(\mathbf{x}_n)$ is the median absolute deviation (Davies, 2009). Once the outliers so identified are dropped, I note that only public spending and openness maintain statistically significance for the sample of democracy. As for dictatorships, all variables become statistically insignificant. Such lack of robustness is hardly surprising because of the remarkable high number of observations which the Hampel methods identify as outliers. Specifically, for the sample of democracies (dictatorships) 100 out of 166 (77 out of 105) observations turn to be outliers, which leaves us with an overall number of observations of just 66 (28).

Another concern with estimations is regime classification. For example, according to the 5-year structure of my data, Mexico 1996-2000 has been recorded as a democracy. However, based on Alvarez *et al*. (1996) rules of classification, Mexico switches to a democracy in 2000, spending the four years between 1996 and 1999 as dictatorship. Thus, it is interesting to check whether the results are robust to reclassification of Mexico 1996-2000 as a dictatorship. More generally, to account for such cases I adopt a regime classification whereby a country-observation is recorded as a democracy (dictatorship) if the country was democratic (dictatorship) for at least three out of five years. Thus, according to this classification, Mexico enters as a dictatorship for overall the sub-periods for which data for the country are available (from 1971 to 2000). The empirical findings are illustrated in Models 5 and 6 of Table A.3. As it can be seen, the results are not affected by such alternative regime classification.

Azerbaijan 2001-2005, Jordan 1986-1990, Kuwait 1981-1985, 1986-1990, 1991-1995, 1996-2000, Madagascar 1981-1985, Malaysia 1991-1995, Mozambique 1996-2000, Philippines 1981-1985, Syria 1986-1990 and Togo 1981-1985.

Levine and Renelt (1992) sensitive analysis has shown physical capital investment to be among the variables with the highest explanatory power for economic growth. Thus, it is of interest to test whether the results are robust to the inclusion of the investment variable (defined as a share of GDP) in the set of regressors. The results are given in Models 1-2 of Table A.4 (Appendix). As can be seen, the coefficient estimate for investment has the expected sign (positive) and is statistically significant for both democracy and non-democracy samples, indicating that an increase in physical capital investment generates faster growth over the next 5 years. The other variables are unaffected by the inclusion of investment.

An additional issue which is worthy of investigation is the 1997-98 East Asian financial crises. As explained above, the endogeneity of credit market imperfections is probably the reason underlying the non-linear relationship between inequality and growth (Barro, 2000). This explanation suggests that financial development might play an important role in shaping the impact of inequality on growth. Since the 1997-98 East Asian crises born out from the financial sector, it would be interesting to include a dummy for the 1996-2000 time period as an additional control variable.[28] The results are illustrated in Models 3-4 of Table A.4 (Appendix). Interestingly, the time dummy is positive and statistically significant for the sample of democracy only. This suggests that democracies grew faster in 1996-2000 than in the previous and following years under analysis, on average. Sign and statistical significance associated with the other variables are preserved.

As a final robustness check, I run a model for the pooled sample of countries which includes a dichotomous variable in the set of regressors to accounts explicitly for the impact of political regime on economic growth. To allow the impact of inequality to vary across political regimes I have interacted both the Gini index and the interaction term with the democracy dummy variable. As shown in Model 5 of Table A.4 the democracy variable is statistically insignificant at any conventional level. This finding implies that being a democracy had no *direct* impact on growth rate for the sample under investigation. This result is in line with Jalles (2010), who show that democratic institutions have neither fostered nor hindered economic growth. The coefficient

[28] As explained in section 2.4.1, the panel data is organized in seven non-overlapping five-year intervals. This time structure does not allow to generate a time dummy for 1997-1998 only.

estimate for the inequality retains its negative sign while the Gini index interacted with the political regime dummy is positive. In line with the findings obtained from running separate regressions, this shows that the impact of inequality on growth is weaker under democracies than under dictatorships.

2.6. Conclusions

Existing empirical findings on the comparative strength of the relationship between income inequality and growth across different political regimes are mixed. This chapter assesses the differential impact of inequality on growth across democracies and dictatorships by using new and more reliable dataset on inequality and political regime and modern methodological tools. Further, it adopts an empirical model which allows the impact of income inequality on growth to vary with income levels.

I find that there is a significant negative relationship between income inequality and economic growth, even after controlling for country-specific characteristics. The results also show that income inequality is harmful for growth, irrespective of whether the country has a democratic or non-democratic government structure. However, when the interaction term between the Gini index and per capita GDP is included in the set of regressors, I find that the impact of inequality on growth turns out to be positive at relatively high levels of income. To examine further the effects of inequality I compute elasticities at different percentiles of income. The findings reveal that the impact of inequality on growth, regardless of whether it is positive or negative, is generally larger for dictatorships as compared to democracies at corresponding percentiles of income.

These results have potentially interesting implications for the debate on the economic performance of different political regimes. Specifically, the findings run counter to theoretical views which view democracy as a luxury that poorer countries cannot afford (e.g. Moyo, 2009).[29] My empirical analysis shows that the negative impact of inequality on growth is less serious under democracies than under dictatorships precisely at relatively low levels of income. If such a superior macroeconomic performance is

[29] In Moyo's popular book *Dead Aid*, it is pointed that "democracy, at the early stages of development, is irrelevant, and may even be harmful" (p. 42). The author adds "In a perfect world what poor countries at the lowest rungs of economic development need is not a multi-party democracy, but in fact a decisive benevolent dictator to push through the reforms required to get the economy moving" (p. 42).

caused by the redistributional mechanism which mitigates the adverse growth effects of inequality, then these findings reveal that democracies are economically valuable in economies where social spending is needed as a remedy for market imperfections and social conflict. In contrast, for richer countries, where equity and efficiency are more likely to conflict with each other, the positive impact of political freedoms on growth might be weaker.

2.7. Appendix A

Table A.1: List of Countries

Always Democracy			
Countries	**Coverage**	**Countries**	**Coverage**
Australia	1991-2005	Japan	1971-2005
Austria	1981-2000	Lithuania	1991-2005
Belgium	1971-2000	Luxembourg	1971-2000
Canada	1975-2005	Malta	1971-2005
Colombia	1971-1985	Mauritius	1971-2000
Costa Rica	1981-2005	Moldova	1991-2005
Croatia	1991-2005	Netherlands	1971-2000
Denmark	1971-2000	New Zealand	1971-2000
Finland	1971-2000	Norway	1971-2005
France	1976-2000	Slovenia	1991-2005
Iceland	1971-2000	Sweden	1971-2000
India	1986-2005	Trinidad and Tobago	1981-2000
Ireland	1971-2000	United Kingdom	1971-2000
Israel	1971-2005	United States	1971-2005
Italy	1971-2000	Venezuela	1971-2000
Jamaica	1971-1985		
Always Dictatorship			
Countries	**Coverage**	**Countries**	**Coverage**
Algeria	1971-2000	Malaysia	1971-2005
Azerbaijan	1991-2005	Morocco	1976-2000
Botswana	1981-2005	Mozambique	1986-2000
Burkina Faso	1971-1985	Qatar	1976-2005
Cameroon	1975-2000	Rwanda	1971-1990
Cote d'Ivoire	1971-1985	South Africa	1986-2005
Egypt	1971-2005	Swaziland	1971-1995
Ethiopia	1991-2005	Syria	1971-2000
Fiji	1971-1985	Tanzania	1971-2000
Gambia	1971-1985	Togo	1971-1985
Iran	1981-2000	Tonga	1981-1995
Jordan	1971-2005	Tunisia	1991-2005
Kenya	1971-1985	Uganda	1986-2005
Kuwait	1975-2005	Zimbabwe	1971-2000
Madagascar	1971-1990		

(*continues*)

Table A.1 (*Continued*)

Political Transition			
Country	**Coverage**	**Entry into Democracy**	**Exit from Democracy**
Argentina	1981-2000	1983	
Bulgaria	1986-2005	1990	
Burundi	1971-1995	1993	
Central African Republic	1981-1995	1993	
Cyprus	1971-2005	1983	
Ecuador	1971-2000	1979	2000
El Salvador	1971-1985	1984	
Ghana	1971-1990	1979	1981
Greece	1971-2000	1973	
Guatemala	1971-2000	1985	1982
Hungary	1971-2000	1990	
Indonesia	1981-2005	1999	
Korea, South	1971-2005	1988	
Malawi	1981-2000	1994	
Mexico	1971-2000	2000	
Nepal	1986-2005	1990	2002
Pakistan	1971-2000	1972	1977
		1988	1999
Panama	1971-2000	1989	
Peru	1981-2000		1990
Philippines	1971-2000	1986	
Poland	1971-2000	1989	
Senegal	1971-2005	2000	
Spain	1971-2005	1977	
Sri Lanka	1976-1995	1989	1977
Suriname	1971-1995	1988	1980
		1991	1990
Thailand	1971-1995	1975	1976
		1979	1991
		1992	
Turkey	1971-2000	1983	1980
	1981-2000	1985	
Uruguay	1981-2000	1985	

Notes: The table illustrates the sample of countries used in the empirical investigation. The last two columns denote a transition toward democracy and dictatorship, respectively.

Table A.2: Definitions of Variables

Variable	Description	Source
Growth	Logarithmic change of real per capita GDP on five-year basis	Author's calculation
Inequality	Estimated Household Income Inequality	UTIP-UNIDO Available at: http://utip.gov.utexas.edu
Income	Natural logarithm of Real GDP per capita (I$ in 2005 Constant Prices: Chain series)	Penn World Table 6.3
Public Spending	Government Share of Real GDP per capita	
Openness	Sum of exports and imports of goods and services (% of GDP)	
Inflation	Annual percentage change in the consumer price index	World Bank
Education	School enrolment, secondary (% gross)	
Democracy	Dummy Variable taking value 1 if the regime is classified as democratic, 0 otherwise	Cheibub *et al*. 2010 Available at: https://netfiles.uiuc.edu/cheibub

Table A.3: Robustness Analysis [1]

Panel A: Estimation Results

	Model 1 (Democracy)	**Model 2 (Dictatorship)**	**Model 3 (Democracy)**	**Model 4 (Dictatorship)**	**Model 5 (Democracy)**	**Model 6 (Dictatorship)**
	Dropping outliers based on growth rates		Dropping outliers based on residuals		Recoding countries that switched political regimes	
$Income_{t-1}$	-5.094***	-7.245***	-4.369***	-9.305***	-4.101***	-9.049**
	(1.662)	(2.584)	(1.472)	(2.967)	(1.553)	(3.767)
$Public\ Spending_{t-1}$	-0.043	-0.051**	-0.056	-0.043	-0.065*	-0.068
	(0.038)	(0.021)	(0.035)	(0.036)	(0.036)	(0.042)
$Education_{t-1}$	0.039***	0.044***	0.038***	0.060***	0.041***	0.058***
	(0.010)	(0.014)	(0.012)	(0.012)	(0.013)	(0.019)
$Inflation_{t-1}$	0.001***	0.000***	0.001**	0.000***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Openness_{t-1}$	0.014***	0.018**	0.015***	0.017**	0.014***	0.016*
	(0.005)	(0.007)	(0.004)	(0.008)	(0.005)	(0.008)
$Inequality_{t-1}$	-0.890**	-1.179**	-0.758**	-1.509***	-0.648**	-1.423**
	(0.365)	(0.477)	(0.352)	(0.491)	(0.324)	(0.628)
$Income_{t-1} * Inequality_{t-1}$	0.092**	0.139**	0.078**	0.174***	0.069**	0.160**
	(0.038)	(0.055)	(0.037)	(0.061)	(0.034)	(0.070)
Constant	48.107***	60.209***	41.619***	77.980***	37.902**	77.644**
	(16.244)	(22.040)	(14.601)	(23.598)	(15.114)	(32.363)

(*continues*)

Table A.3: Robustness Analysis (*Continued*)

Panel B: Diagnostic tests						
	Model 1 (Democracy)	**Model 2 (Dictatorship)**	**Model 3 (Democracy)**	**Model 4 (Dictatorship)**	**Model 5 (Democracy)**	**Model 6 (Dictatorship)**
	Dropping outliers based on growth rates		Dropping outliers based on residuals		Recoding countries that switched political regimes	
AR(2)	0.220	0.081	0.267	0.153	0.209	0.838
Hansen test	0.633	0.983	0.575	0.965	0.411	0.933
Observations	161	92	154	85	159	112
Countries	56	43	56	40	54	47
Instruments	38	45	31	44	46	45

Notes: The table shows the main determinants of economic growth. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively

Table A.4: Robustness Analysis [2]

Panel A: Estimation results

	Model 1 (Democracy)	Model 2 (Dictatorship)	Model 3 (Democracy)	Model 4 (Dictatorship)	Model 5 (Full sample)
$Income_{t-1}$	-10.358***	-13.757***	-4.942***	-9.917**	-9.046***
	(3.447)	(4.076)	(1.818)	(4.279)	(2.813)
$Public\ Spending_{t-1}$	-0.084**	-0.096***	-0.060*	-0.091**	-0.067**
	(0.040)	(0.035)	(0.032)	(0.043)	(0.032)
$Education_{t-1}$	0.045***	0.064***	0.039***	0.066***	0.058***
	(0.015)	(0.017)7	(0.013)	(0.021)	(0.012)
$Inflation_{t-1}$	0.001***	0.000***	0.001***	0.000**	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
$Openness_{t-1}$	0.020***	0.020***	0.012**	0.024**	0.010*
	(0.007)	(0.007)	(0.006)	(0.011)	(0.005)
$Inequality_{t-1}$	-1.903**	-2.152***	-0.797**	-1.420**	-1.873***
	(0.747)	(0.623)	(0.377)	(0.589)	(0.528)
$Income_{t-1}*Inequality_{t-1}$	0.192**	0.247***	0.083**	0.170**	0.186***
	(0.077)	(0.077)	(0.040)	(0.076)	(0.058)
$Investment_{t-1}$	0.063**	0.077**			
	(0.032)	(0.038)			
1996-2000			0.655*	0.254	
			(0.344)	(1.031)	
DEM_{t-1}					-4.327
					(5.568)

(*continues*)

Table A.4: Robustness Analysis (*Continued*)

	Model 1 (Democracy)	**Model 2 (Dictatorship)**	**Model 3 (Democracy)**	**Model 4 (Dictatorship)**	**Model 5 (Full sample)**
$Inequality_{t-1}*DEM_{t-1}$					0.410**
					(0.177)
$Income_{t-1}*Inequality_{t-1}*DEM_{t-1}$					-0.034**
					(0.015)
Constant	98.897***	115.505***	46.269***	80.346**	88.911***
	(33.923)	(32.64)	(17.205)	(32.241)	(25.416)
Panel B: Diagnostic tests					
AR(2)	0.221	0.896	0.537	0.155	0.848
Hansen test	0.475	0.741	0.577	0.877	0.755
Observations	166	105	166	105	271
Countries	56	46	46	45	88
Instruments	37	39	46	46	54

Notes: The table shows the main determinants of economic growth. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the p-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Figure 2.1: Elasticity of Growth with respect to Income Inequality across Income Percentiles – Full Sample

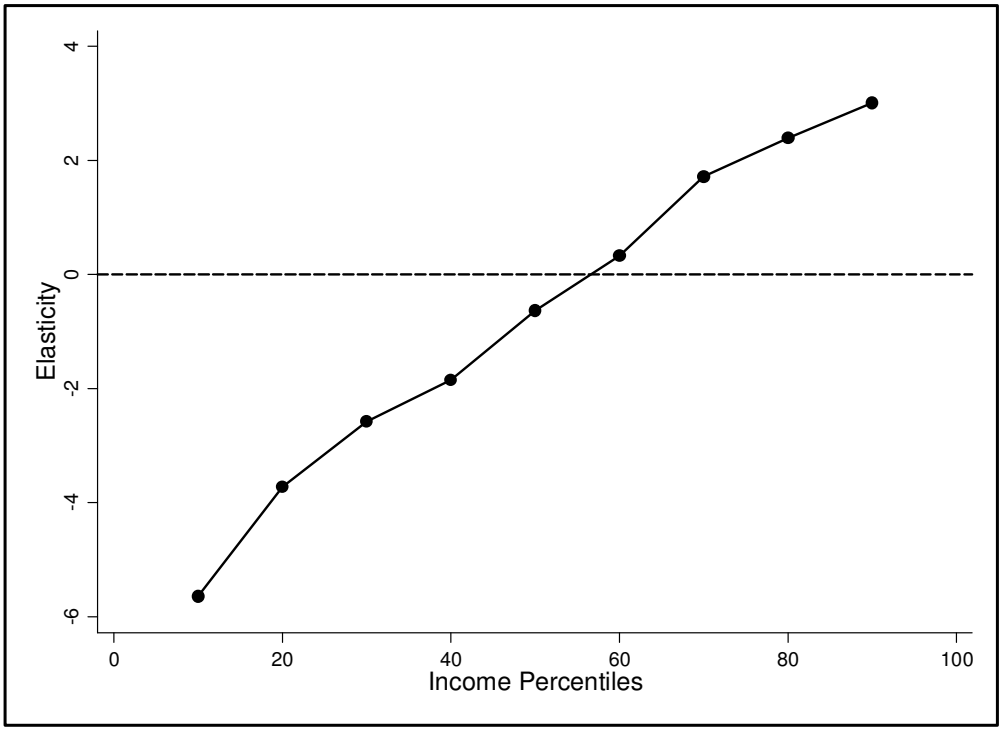


Figure 2.2: Elasticity of Growth with respect to Income Inequality across Income Percentiles – Democracies vs. Dictatorships

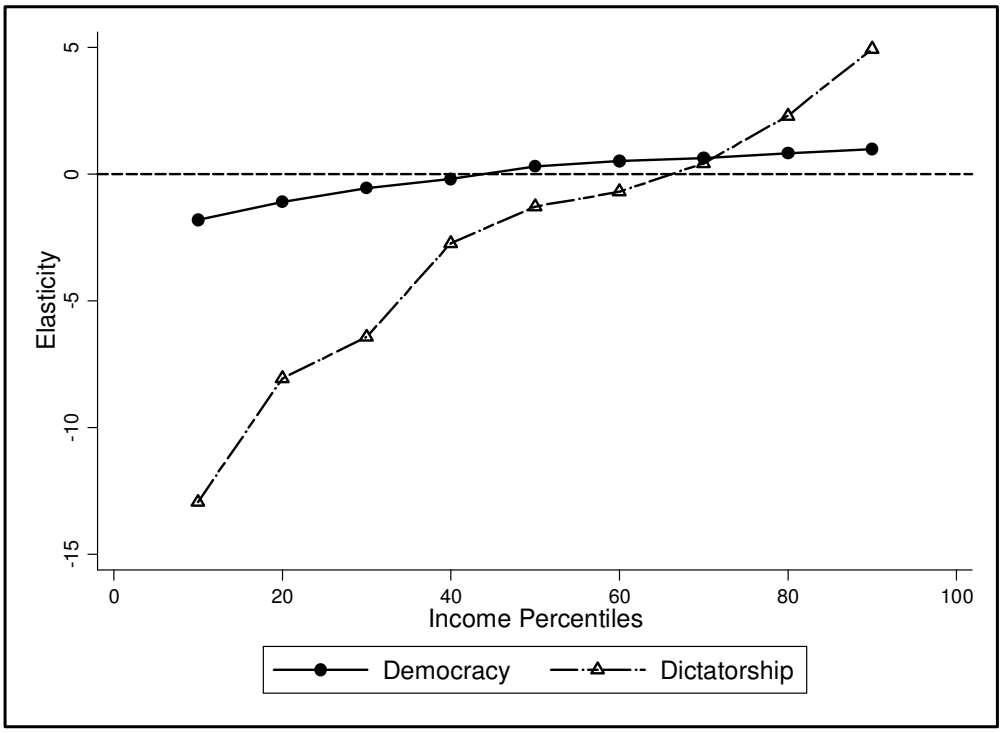


Figure 2.3: Residuals versus fitted values plot – Democracies

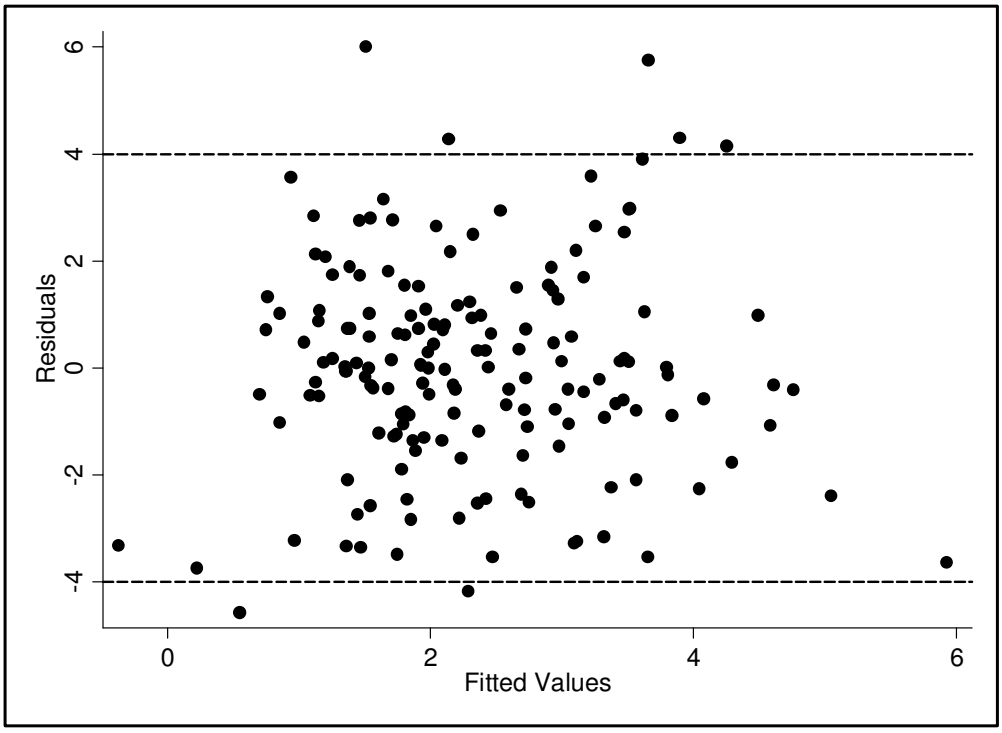
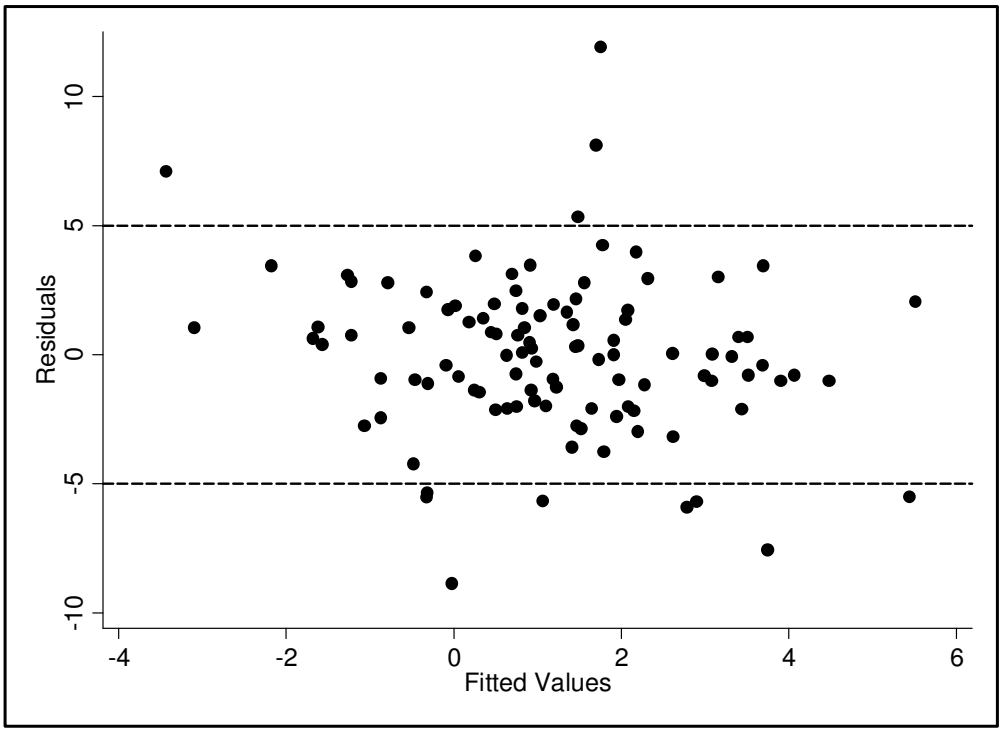


Figure 2.4: Residuals versus fitted values plot – Dictatorships



Chapter 3 : Absolute Poverty, Relative Poverty and Financial Development

3.1. Introduction

A large body of literature has successfully established a significant relationship between a financial system which effectively provides financial services and the process of economic growth (e.g. King and Levine, 1993; Beck *et al.*, 2000; Beck and Levine, 2004). In recent years another strand of literature has focused on whether and how a well-functioning financial system affects the standard of living for the poor. The central issue under consideration is whether financial development is conducive to poverty reduction, or whether in fact it advantages the rich with no benefit to (or at the expense of) the poor.

From a theoretical point of view, the impact of financial development on poverty alleviation is ambiguous. In the presence of credit market imperfections, poorer households who are unable to obtain funds from markets tend to discard investments in human and physical capital which are highly rewarding in the long term (e.g. Galor and Zeira, 1993; Aghion and Bolton, 1997; Barro, 2000). Thus, to the extent that liquidity constraints are relaxed, the impact of financial development is likely to be beneficial for the poor. Moreover financial development might benefit the poor indirectly, through its positive impact on economic growth (see, for example, Demirgüç-Kunt and Levine, 2009). On the other hand, improvements in the financial system may principally advantage families and firms which are already using financial services. For example, Rajan and Zingales (2003) and Claessens and Perotti (2007) argue that the financial system, especially where governments are weak, might mainly convey resources to the rich and elites with strong political connections, while leaving out the poorer fractions of the population.

On empirical grounds, when testing the effect of financial development on poverty one would ideally use a measure which gauges how well the financial system performs its functions. However, there is no adequate conceptual framework to reduce the notion of financial development to a single aggregate index. Instead the literature has relied on

several indicators each one focusing on a specific dimension of the financial system. The most commonly used proxies of financial development, such as *liquidity liabilities, private credit and stock market capitalization*, are measures of the size of the financial sector. Other indices, such as *commercial-central bank* and *turnover ratio*, reflect mainly the efficiency and the degree of liquidity of the financial sector. I explain each of the mentioned indicators in detail in section 3.4.

Several empirical works, based on large sample of countries, have used one or more proxies of financial development to assess whether financial development alleviates *absolute* poverty, commonly measured as the percentage of the population living below a specified poverty line, for example $2 a day (Honohan, 2004; Beck *et al*., 2007; Akter *et al*., 2010; Perez-Moreno, 2011; Jeanneney and Kpodar, 2011). Additional research has been done to estimate the impact of financial development on the poorest 20 % of population relative to the national income, which is seen as a measure of *relative* poverty (Jalilian and Kirkpatrick, 2005; Beck *et al*., 2007; and Jeanneney and Kpodar, 2011).[1] The empirical evidence found by these studies is in favour of a positive impact of financial development on the income share of the poorest quintile. Still further work have analysed the linkage between financial development and poverty within single countries (e.g. Quartey, 2005; Odhiambo, 2009; Inoue and Hamori, 2012; Ho and Odhiambo, 2011). Taken together, these studies find that financial development has decreased the number of people below the poverty line and it has increased the share of the income accruing to the lowest quintile.

On the other hand, it does not seem safe to say that the theoretical ambiguity concerning the effect of financial development on poverty alleviation has been settled empirically because of methodological limitations with prior analyses. As it will be discussed in section 3.3, most of the afore-mentioned studies suffer from sample heterogeneity and/or omitted variable bias. In addition, only two studies, namely Beck *et al*. (2007) and Jeanneney and Kpodar (2011), analyse the impact of financial development on both absolute and relative poverty. This chapter is aimed at empirically reassessing the impact of financial development on absolute poverty as well as relative poverty while overcoming the methodological difficulties which characterize previous studies. The

[1] Beck *et al*. (2007) and Jeanneney and Kpodar (2011) consider the headcount index as well as the bottom quintile while Jalilian and Kirkpatrick (2005) focus only on the latter index.

results show that the impact of financial development on poverty alleviation is statistically significant when liquid liabilities and credit granted to the private sector is used as proxy of financial development and poverty is measured either by the headcount index or the poverty gap. However, the empirical estimates provide little evidence for a causal link from financial development to poverty when alternative indices of financial development, namely stock market capitalization, commercial-central bank and turnover ratio, are used. When the focus of the analysis is moved to the income share of the poorest quintile, the empirical results yield no evidence for a significant impact of financial development on the poor, whatever the proxy for financial development. Taken together, these findings suggest that the inference for a pro-poor effect of financial development depends primarily on the measure of poverty. The results also show that the choice of the proxy for financial development is relevant in assessing the poverty reduction effect of financial development.

The rest of the chapter is organized in the following way. Section 2 illustrates theoretical and empirical literature review. Section 3 presents the investigation plan, including the empirical model and the methodological technique. Section 4 explains the sample under investigation and illustrates the alternative indices of financial development used. Section 5 shows the findings of the empirical investigation. Section 6 summarizes the empirical findings and provides some concluding remarks.

3.2. Literature Review

In recent years a growing strand of literature has debated whether and how the development of the financial system could have any relevant effect on the standard of living for the poor. In this section I discuss the two main mechanisms by which financial development might affect the poorest segments of the population. Then I illustrate the studies which have looked at the empirical evidence.

3.2.1. The Direct use of Financial Services by Poor Households

One of the main debates in the economic literature revolves around the impact of an uneven distribution of wealth on the agents' economic opportunities. If markets were

perfect, poor endowed households could borrow from credit markets to implement their investment projects. Thus, a talented but poor individual would still be able to grow out of poverty by obtaining from the market the funds that she lacks. On the other hand, in presence of credit imperfections markets are unwilling to lend to those who cannot provide sufficient collateral for the loan (Stiglitz and Weiss, 1981). Under such circumstances, individuals' economic opportunities are strictly determined by their parental wealth: an individual from a poor dynasty will hardly step out of poverty, however talented she is (Galor and Zeira, 1993; Banerjee and Newman, 1993; Aghion and Bolton, 1997).

On the theoretical side, financial development could benefit the poorer segments of the population by expanding the financial services to the poor who were previously unable to borrow (Demirgüç-Kunt and Levine, 2009). For example, a lower reserve requirement could boost the supply of credit to private agents, including the poor ones. On the other hand, the benefits from increasing availability of credit might principally accrue to the insiders, thereby leaving the poorest fraction of the population unaffected by a deepening in the financial system (Claessens and Perotti, 2007). In fact, the access to credit could even narrow if financial development generates a shift of resources from the informal to the formal sector – given that the informal sector is the main source of funds for the poor (Arestis and Caner, 2009). Thus, whether financial development could have any direct effect on poverty alleviation seems to be an empirical issue.

3.2.2. The Economic Growth Channel

A large body of theoretical literature suggests that the development of the financial sector mitigates asymmetric information and transaction costs which prevent economic agents from exploiting profitable investment opportunities, thereby leading to an improvement in the allocation of resources (see Levine, 2005, and the reference therein). On the empirical side, several studies have provided evidence in favour of a positive impact of financial development on economic growth (e.g. King and Levine, 1993; Levine and Zervos, 1998; Beck *et al.*, 2000; Fink *et al.* 2003; Beck and Levine, 2004). If a trickle- down effect is at work it follows that financial development will

mitigate poverty indirectly through an increase in the economic growth rate (Arestis and Caner, 2009).[2]

In addition, a higher growth rate means that the policy maker can rely on a larger amount of resources which could be redistributed in order to mitigate poverty incidence. Financial development can also mitigate poverty by boosting the income share of labour – given that labour is the main income source of the poor. Specifically, by stimulating economic growth financial development might raise the demand for labour. If such higher demand is directed toward low-skilled labour, then financial development will lead to further poverty alleviation. In practice, whether this is the case depends on whether the increase in the growth rate fosters the demand for low or high skilled labours (Jerzmanowski and Nabar, 2013).

3.2.3. Empirical Studies

In this section I summarize previous empirical works on the financial development-poverty nexus based on large sample of countries. Overall, the empirical evidence is in favour of a significant impact of financial development on poverty alleviation.

Honohan (2004) examines the relationship between financial development and the $2 per day poverty ratio using cross-country analysis for a set of more than 70 developing economies. He shows that the amount of private credit is negatively associated with the poverty rate. However, he finds little evidence for a significant relationship between stock market development, proxied by either stock market capitalization or turnover ratio, and poverty incidence. The estimated relationships are robust to the selection of a lower poverty line, namely $1 per day.

Jalilian and Kirkpatrick (2005) use a large sample of countries to assess the impact of financial development on the poorest 20% of the population. To do so, they estimate three models separately, namely: (i) the linkage between financial development and growth; (ii) the linkage between financial development and inequality; (iii) the linkage

[2] Based on a sample of 92 countries, Dollar and Kraay (2002) find that the elasticity of income share of the bottom quintile to growth is equal to one, which means that growth benefits the poor as much as everyone else.

between economic growth and poverty. They find that financial development (proxied by private credit) fosters growth, especially in poorer countries; that the relationship between financial development and growth is inverted U-shaped; and that the growth accrues to the poorest quintile as much as anyone else. On the basis of their findings Jalilian and Kirkpatrick estimate that a one unit increase in private credit raises the income growth of the poor by 0.3 per cent.

Beck *et al*. (2007) use changes in the poorest quintile and changes in the headcount index of poverty in the attempt to assess the effect of financial development on the poor. Their sample covers a number of countries up to 72 over the period 1960-2005. As for the estimation technique, they employ cross-country regressions as well as longitudinal approach based on the system generalized methods of moments panel estimator. Their results show that the a rise in financial development, measured by either private credit or commercial central bank ratio, boosts the income share of the poorest quintile and decreases the number of people living under the poverty line of $ 1 a day.

Akhter *et al.* (2010) employ a fixed-effect vector decomposition (FEVD) to examine the relationship between financial development and the headcount index of $ 1 a day for a sample of 54 developing countries spanning over the period 1993-2004. Unlike Fixed Effect estimators, the FEVD approach allows the authors to include time invariant or slowly changing variables, such as the country's legal origin and the level of corruption, in the set of controls. Their results reveal that financial development is conducive to poverty alleviation. In addition, the authors show that an increase in private credit has a larger impact on poverty than an increase in liquid liabilities.

Jeanneney and Kpodar (2011) uses system GMM estimation approach to examine the effect of financial development on the poorest quintile poverty for a dataset of 75 developing countries over the period from 1950 to 1999. To proxy for financial development they use the value of credit to private sectors as well as a broad index of liquid liabilities. Their findings show that higher levels of liquid assets lead to poverty alleviation. However, unlike Akhter *et al*. (2010), they find little evidence for a significant impact of private credit on poverty. They also show that the results remain unchanged when the $1 per day poverty line is used as a measure of poverty. Similar evidence is provided by Moreno (2011) who uses a Granger causality test to assess the

linkage between financial development and the poverty headcount indices at $2 and $1 a day for a sample of 35 developing countries spanning three decades from 1970 to 2000.

3.3. Investigation Plan

As the reader might have observed, empirical works so far have corroborated a pro-poor impact of financial development. From this empirical evidence it follows that the policy maker who desires to alleviate poverty could pursue policies which foster financial development rather than relying on more explicit redistributive policies. The underlying reason is that, unlike non-lump sum redistribution, financial development mitigates poverty without any adverse effect on the incentives to invest by the rich (Beck *et al*., 2007). However, when looking at the empirical literature, one can observe that previous analysis suffer from one or more of the following problems:

1) Sample heterogeneity
2) Omitted variable bias
3) Omission of relative poverty

When testing the impact of financial development on poverty, both Jalilian and Kirkpatrick (2005) and Beck *et al*. (2007) use a sample which includes developed as well as developing countries. However, empirical estimates based on a pooled sample of countries are likely to suffer from heterogeneity problems. For example, if richer countries have a higher level of financial development as well as lower poverty, running a pooled sample might yield an overly optimistic estimate of the impact of financial development on poverty. Both studies include in their set of explanatory variables an interaction term between the proxy of financial development and a dummy for poor countries or the level of GDP to allow for a differential effect of financial development on poverty across different income levels. However, they do not use similar interaction terms for other explanatory variables, neither do they run any test to check whether the coefficients are different across poor and rich countries.

The estimates provided by Honohan (2004) are likely to suffer from omitted variable bias because cross-sectional regressions do not control for unobserved country-specific effects. Furthermore, cross-section analyses ignore any available information in the time-series dimension of the data. Jeanneney and Kpodar (2011) address these difficulties by using a system GMM estimator for a sample including only developing countries. Yet, their results are also subject to omitted variable bias because they do not include the lagged dependent variable in their set of explanatory variables.

Honohan (2004), Akter *et al*., (2010) and Perez-Moreno (2011) focus on absolute poverty while ignoring relative poverty. However, this might be an incomplete approach for estimating the impact of financial development on poverty. The reason is that absolute levels of poverty are generally not too high in middle income economies, yet the distribution of wealth in developing countries is quite uneven, with the bottom quintile of the population sharing only a very small fraction of the national income (high relative poverty). This is indeed the case for some South American countries, such as Brazil, Argentina and Peru, where the headcount index based on the $1 poverty line is less than 1%, yet the income share of the poorest quintile is less than 3 %, which is quite below the sample mean, namely 5.6% (see Table 3.1). Thus, measures of both absolute and relative poverty should be used to properly evaluate the relationship between financial development and the poor.

This study overcomes some of the problems reported in the previous empirical literature in three ways. First, it systemically studies the financial development-poverty nexus using alternative indices of *absolute* poverty as well as measure of *relative* poverty. Second, to mitigate sample heterogeneity from using pooled sample of both rich and poor countries, this study focuses on a sample of developing economies while leaving developed economies out of the analysis. Third, to address the dynamics bias associated with the inclusion of the lagged dependent variables in the set of explanatory variable, I use a two-step system GMM estimator. This methodology also effectively addresses the omitted variable bias from unobserved heteroskedasticity. A number of indices which gauge the size and the liquidity/efficiency of the financial sector are employed to proxy for financial development.

3.3.1. Empirical Model and Strategy

The main aim of this study is to examine the direct effect of financial development on poverty using alternative measures of poverty as well as different proxies of financial development. To conduct my empirical analysis, I estimate a dynamic panel regression model as follows:

$$Pov_{i,t} = \alpha_i + \beta Pov_{i,t-1} + \gamma FD_{i,t} + \Gamma X_{i,t} + \lambda_t + \varepsilon_{i,t} \quad (1)$$

$$\varepsilon_{i,t} = \eta_i + \nu_{i,t}$$

where i represents country and t stands for time period. $Pov_{i,t}$ is the measure of poverty, and $FD_{i,t}$, the main variable of interest, is the proxy for financial development. X is a vector of additional explanatory variables including per capita growth rate, inflation rate, the Gini index of inequality, public spending, primary school enrollment and an index for the quality of institutions. $\varepsilon_{i,t}$ is the composite error term, $\eta_{i,t}$ is the country-specific effect and $\nu_{i,t}$ is an idiosyncratic error. λ_t is a time-specific effect which is captured by a set of time dummy variables. The inclusion of the lagged dependent variable $Pov_{i,t-1}$ on the right-hand side allows us to model the dynamic process underlying poverty incidence and to account for inertia effects.

The selection of the set of explanatory variable in matrix *X* is based on previous empirical studies. Specifically:

1) The growth rate is included to isolate the impact of financial development on poverty from its growth effect (Arestis and Caner, 2010). Countries which grow faster are likely to experience larger drops in poverty because of the trickle-down effect and potentially increases in the demand of low-skilled workers from the expansion of economic activity. Thus, growth is expected to mitigate poverty incidence.
2) Inflation, measured as the change in the consumer price index, is included to control for the instability of the macroeconomic environment (Jeanneney and Kpodar, 2011). Inflation is expected to worsen poverty because the poor generally have a

larger fraction of their wealth in cash than richer individuals. In addition, unlike the capital rents, income wages – the main source of income for the poor- are not perfectly indexed to inflation (Easterly and Fischer, 2001).

3) Public spending (expressed as share of GDP) is a proxy of the overall size of government. It has been included to control for public policies which transfer income from the wealth to the poor, such as state subsidy and public expenditure for education. The impact of public consumption expenditure is a priori ambiguous because it depends largely on the extent to which public resources are employed for uses which primarily benefit the poor (Dollar and Kraay, 2002).
4) Education, calculated as the primary school enrolment, is included to control for human capital investment. Education is generally thought to mitigate the levels of poverty (Christiaensen *et al*., 2003). In practice, whether the level of education is conducive to lower poverty depends on the extent to which households can afford to send their children to school.
5) A proxy for institutional quality has been included because institutional characteristics such as corruption in the political system and quality of bureaucracy can affect poverty reduction (Chong and Calderón, 2000). Institutional reforms which widen the formal sector at the expense of the informal sector might entail high transaction costs for the poor. On the other hand, a higher level of institutional quality is likely to improve the effectiveness of public services. Therefore, the sign associated with quality of institutions is ambiguous.
6) The Gini coefficient is included to purge the effect of financial development on poverty from its distributional effects (Jalilian and Kirkpatrick, 2005). Given the level of growth, the higher the level of inequality, the lower the share of rising income which accrues to the poor. On the other hand, when the level of inequality is high, there are a large number of poor households which the growth can potentially benefit. Thus, the sign of the Gini index is ambiguous. The Gini coefficient is excluded in the regression on the poorest quintile since both variables, though with some differences, are concerned with distributional issues.

α, β, γ and Γ denote the parameters to be estimated. The specific impact of financial development on poverty is revealed by the coefficient γ. When either the poverty headcount index or the poverty gap is used as the dependent variable, a negative sign of

γ reveals that higher levels of financial development lead to poverty alleviation in absolute terms. On the contrary, a positive sign means that a higher degree of financial development is harmful to the poor. When the income share of the poorest 20% of the population appears as the dependent variable, then a positive sign of γ suggests that as an economy achieves higher levels of financial development the income share accruing to the poor increases (relative poverty decreases). On the other hand, a negative sign of γmeans that higher levels of financial development lower the income share of the poorest quintile (relative poverty increases).

All the above scenarios assume that $\gamma$is statistically distinguishable from zero. Conversely, if the coefficient fails to achieve the standard levels of significance, then the estimates imply that the impact of financial development on poverty is statistically irrelevant. It is important to remember that financial development might also have an impact on poverty indirectly, for example, via rising levels of economic growth and demand for unskilled labour. Such effects could be assessed by a structural system which accounts for all the relevant channels. However, this is beyond the scope of the current investigation.

3.3.2. Estimators

To estimate the empirical model I use a system GMM panel estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). This technique runs a system of two equations, one in levels and the other in first-differences. The estimator uses the lagged values of the explanatory variables, in levels as well as in first-differences, as IV instruments for the respective equations ("internal" instruments). A number of "external" instruments for financial development and growth, taken from the empirical literature, have also been used as additional IV variables. This set of instruments includes legal origin (La Porta *et al.*, 1999), ethnic fractionalization (Easterly and Levine, 1997), total population (Beck *et al.*, 2008), trade openness (Islam, 1995), investment (Mankiw *et al.*,1992) and two dummies variables for oil exporter and tropical countries (Sachs and Warner, 1995; Beck, 2011).

The system GMM estimator controls effectively for unobserved country-specific effects and mitigates the problem of measurement error. Contrary to within estimators, system GMM leads to consistent parameter estimates in presence of the lagged dependent variable on the right hand side of the equation.

To be a valid IV variable, the set of instruments has to satisfy the population moment conditions used by the estimation process. The validity of this assumption can be assessed empirically by checking the Hansen test of over-identifying restrictions. Failure to reject the null hypothesis supports the overall validity of the instruments. An additional assumption has to be satisfied to generate consistent GMM estimates. Specifically, it is required that the error term $v_{i,t}$ exhibits no serial correlation higher than order one. Such assumption can be tested with the Arellano and Bond test. If the null hypothesis is not rejected, then second-order serial correlation can be discarded.

3.4. Data, Sample and Variable Definitions

3.4.1. The Sample

My investigation focuses on an unbalanced panel set of countries over the period 1985-2008. The size of the sample varies depending mainly on the availability of data for the proxy of financial development. Following Arestis and Caner (2010), I average the variables over four-year intervals to maximize the number of country-observations. This also allows us to abstract from short run disturbances. Thus, the panel includes observations with a maximum of six periods. Only countries with observations for at least two consecutive periods are included in the panel.

To mitigate sample heterogeneity, I focus on the sample of less-developed countries only. Specifically, any country which is classified by the World Bank as high income has been excluded ($12,476 or more according to the 2011 GNI per capita). Doing so also yields more salient results from the viewpoint of policy, since the nexus between financial development and poverty is most debated precisely in developing countries. The complete list of countries is displayed in Appendix, Table B.1

Most of the data are collected from the World Bank's Financial Structure and Economic Development Database (2010) and the World Development Indicators (2012). Table B.2 in Appendix provides a description of the main variables with data sources. The measures for poverty as well as the proxies of financial development used in this study are briefly discussed in the next two sections.

3.4.2. Alternative Indices of Poverty

Poverty has been defined and operationalised in different ways (see e.g. Grusky and Kanbur, 2006). One classical measure of poverty counts how many people live with an income below a threshold line based on a minimum amount of resources needed to sustain life. One problem which arises when assessing poverty at the global level is the heterogeneity of data on poverty across different countries. An attempt to set an international poverty line has been made by Ravallion, Chen and Sangraula (2009). Specifically, they compile a dataset of national poverty lines based on the World Bank's *Poverty Assessment* and country governments' *Poverty Reduction Strategy Papers* and other sources for 75 developing countries. Using the 2005 purchasing power parity (PPP), Ravallion *et al*. (2009) define the poverty line at $ 2 a day, which corresponds to the median line in their sample of countries. A more "conservative" poverty line is that of $ 1.25 a day, which is the average of the lines for the sub-sample of the 15 poorest countries.

In keeping with standard development literature, I use the *headcount* poverty index based on $ 2 and $ 1.25 a day. This index simply counts the number of people with per capita consumption (or income) below the poverty line. One problem with such an index is that it does not reflect the "breadth" and intensity of poverty. Such kind of information is reflected in my second measure of poverty, namely the *poverty gap* index. The higher the index, the farther is the average poor from the poverty line.

While the headcount index and poverty gap based on the $ 2 and $ 1.25 a day provide a measure of absolute poverty, they give no sense of the extent of relative poverty. For this reason, I use the income share of the *poorest quintile* as an additional indicator of poverty. Increasing levels of poorest quintile means that a higher share of the income is

accruing to the poorest 20% of population. It is important to note that the correlation between the Gini index and the poorest quintile, about – 0.97, is very high (see Table 3.2 displayed in section 3.5.1), meaning that when income share of the poorest 20% increases (decreases), inequality will decrease (increase). Such a strong correlation reveals that the poorest quintile is closely concerned with distributional issues. Thus, the present analysis is dealing with both poverty and inequality.

3.4.3. Alternative Indices of Financial Development

A proper index of financial development would ideally provide a direct measure of the extent and effectiveness to which the financial system performs its main functions such as risk amelioration, information processing and monitoring services.[3] However, summarizing the stage of development achieved by the financial system in a single aggregate measure is not a straightforward task. Instead, empirical works use several indices, each with its own advantages and weakness, which operationalize the financial system in different ways. Therefore, to carry my empirical investigation, I rely on the most commonly used indices in the literature on financial development.

The first proxy of financial development is *liquid liabilities*, which is M3, expressed as a share of GDP, where M3 consists of currency as well as demand and interest-bearing liabilities of bank and non-bank financial institutions. This index gauges the size of the formal financial system relatively to the size of the real economy. It has been extensively used in the empirical literature on finance, growth and poverty (e.g. King and Levine, 1993; Perez-Moreno, 2011; Jeanneney and Kpodar, 2011).

As M3 focuses on the liabilities side of the financial system, it does not seize one of the most relevant financial services, namely credit allocation. This brings us to the second proxy of financial development, namely *private credit*, which gauges the amount of credit provided to the private sector by financial intermediaries as a share of GDP.[4] This is a standard variable in the finance literature and it has been used, among others by Honoan (2004), Beck *et al*. (2007) and Perez-Moreno (2011), to analyse the impact of

[3] In Demirgüç-Kunt and Levine's words "the inverse of the cost of joining the financial intermediary represent the level of financial development" (2009, p. 16).
[4] Financial intermediaries are banks, bank-like and non-bank institutions, such as insurance companies, pension funds and mutual funds.

financial development on poverty rate. This measure excludes credit to the public sector such as government and public enterprises. Also, unlike liquid liabilities, it omits credits issued by central banks and government agencies. The intuition underlying this index is that financial systems which engage with the private sector provide more valuable services than systems that confine financial services to the public sector (Beck and Demirgüç-Kunt, 2009).

As an additional indicator of financial development, this study uses the *commercial-central bank asset ratio*, which equals the amount of bank deposits divided by the assets of the central bank. This index captures the efficiency with which banks provide financial functions. The rationale underlying this proxy is that commercial banks perform financial intermediation services more effectively than central banks do (Beck and Demirgüç-Kunt, 2009). This index has been firstly used by King and Levine (1993) to examine the finance-growth nexus and it has been extended by Dollar and Kraay (2002) and Beck *et al*. (2007) to analyse the impact on poverty.

While the afore-mentioned indices are mainly concerned with the banking sector, they give no sense of the development of the stock market. However, a number of theoretical studies have pointed out that stock markets also provide an important channel of financial intermediation (e.g. Levine, 1991 and Bencivenga *et al*., 1995). On the empirical side, several studies, such as Levine and Zervos (1998) and Beck and Levine (2004), have shown that capital markets play an important role in economic growth. To account for the potential role of equity market on poverty incidence, I use two further proxies of financial development, namely *stock market capitalization to GDP* and *turnover ratio*. The former, is a proxy for the size of the stock market, and measures the amount of shares listed on the domestic stock exchange as a share of the GDP. The latter, is an index for the liquidity of the stock market, and measures the value of shares traded on the domestic stock exchange divided by stock market capitalization. Both measures have been used by Honoan (2004) in the analysis of the financial development-poverty nexus.

Before concluding this section, it should be noted that the literature on financial development provides a large number of variables to proxy for financial development. Unfortunately, some of these variables, such as deposits and the number of bank

branches per 1000 people, are unavailable for a large panel of countries. Other indices are scarcely available for developing countries because they refer to institutional investors, such as insurance companies and mutual funds, which operate mostly in developed countries. Still other proxies are strongly correlated with the proxies used here. For example, the correlation between private credit and the overall amount of deposits held in the banking system is quite high, approximately 0.88 (results not shown here). This should not be surprising because the bulk of financial services in developing country are provided by banks (Beck and Demirgüç-Kunt, 2009). Thus, I believe that the choice of the above indices suffices for the purpose of the current investigation. In addition, the specific set of indices under analysis makes my results comparable with previous empirical studies of financial development and poverty.

3.5. Results and Analysis

3.5.1. Overview of the Data

Table 3.1 illustrates descriptive statistics for the largest sample available for empirical analysis. Rates of poverty vary considerably across countries. For example, the headcount index at $2 a day ranges from virtually zero (no poor) for Bulgaria in 1989-1992 to 0.94 (almost all poor) for Malawi in 1997-2000. Similarly, income share held by the poorest quintile fluctuates from just 1% in Panama in 1989-1992 to 10.12% in Bulgaria in 1997-2000.

Growth rate of per capita GDP and primary education also show considerable variation. The lowest per capita GDP growth rate is recorded in Romania in the years 1989-1992, while the highest per capita GDP growth has been seen in Azerbaijan in 2005-2008. The panel also includes cases of hyperinflation, such as Argentina and Brazil in the years between 1989 and 1992, with rates of inflation above 1000.

Table 3.2 displays the correlations between the indices of poverty and the independent variables. With the exception of turnover ratio, the proxies of financial development are all significantly correlated with the headcount ratio and poverty gap, though the size of the correlation is not high.

Table 3.1: Summary Statistics

Variables	Mean	Std. Dev.	Min	Max
Headcount ($2 at day)	0.347	0.287	0.000	0.935
Headcount ($1.25 at day)	0.204	0.227	0.000	0.831
Poverty gap ($2 at day)	15.386	15.890	0.000	62.270
Poverty gap ($1.25 at day)	7.905	10.115	0.000	45.960
Poorest quintile	5.628	2.161	1.000	10.120
Liquid liabilities	0.402	0.254	0.057	1.260
Private credit	0.313	0.263	0.024	1.450
Commercial-central bank	0.787	0.186	0.145	1.000
Turnover ratio	0.264	0.424	0.001	2.909
Stock market capitalization	0.268	0.391	0.001	2.547
Institutions	4.682	1.247	0.556	7.708
Growth	2.810	3.546	-8.035	22.570
Inflation	36.655	150.985	-3.973	1440.722
Gini	43.262	9.121	24.385	60.530
Public spending	12.984	4.225	3.482	26.438
Education	101.740	18.749	26.148	150.978

Notes: The table illustrates summary statistics of the main variables. Headcount, poverty gap and the poorest quintile are the dependent variables.

Table 3.2: Correlation Matrix [1]

	Headcount ($2)	Headcount ($1.25)	Poverty gap ($2)	Poverty gap ($1.25)	Poorest Quintile
Liquid liabilities	-0.360	-0.388	-0.388	-0.385	0.113
	(0.000)	(0.000)	(0.000)	(0.000)	(0.100)
Private credit	-0.348	-0.357	-0.360	-0.350	-0.092
	(0.000)	(0.000)	(0.000)	(0.000)	(0.181)
Commercial-central bank	-0.264	-0.286	-0.295	-0.312	0.051
	(0.000)	(0.000)	(0.000)	(0.000)	-0.440
Turnover ratio	0.186	0.101	0.099	-0.014	0.236
	(0.017)	(0.196)	(0.206)	(0.863)	(0.002)
Stock market capitalization	-0.212	-0.215	-0.226	-0.231	-0.056
	(0.007)	(0.006)	(0.004)	(0.003)	(0.472)
Institutions	-0.262	-0.251	-0.250	-0.221	-0.038
	(0.000)	(0.000)	(0.000)	(0.000)	(0.566)
Growth	-0.110	-0.130	-0.138	-0.161	0.258
	(0.095)	(0.048)	(0.036)	(0.014)	(0.000)
Inflation	-0.117	-0.092	-0.093	-0.068	-0.106
	(0.076)	(0.166)	(0.159)	(0.302)	(0.105)
Gini	-0.058	0.013	0.038	0.144	-0.971
	(0.380)	(0.849)	(0.567)	(0.028)	(0.000)
Public spending	-0.222	-0.156	-0.155	-0.084	-0.031
	(0.000)	(0.018)	(0.018)	(0.203)	(0.639)
Education	-0.335	-0.326	-0.321	-0.284	-0.306
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: The table shows simple correlations between the set of dependent variables and the explanatory variables (*p*-values in parentheses).

On the other hand, the corresponding correlations with the poorest quintile are statistically insignificant. This provides some preliminary evidence that the impact of the financial market depends on both the measures of poverty and financial development. Similarly, the pairwise correlations show that poverty and inflation are not significantly correlated with each other.

Table 3.3 illustrates the correlations between the indices of poverty. As it can been seen, the headcount index and poverty gap are strongly correlated. On the other hand, the correlations between the poorest quintile and the two absolute indices of poverty are very low and, with the exception of the headcount at $ 2 a day, not statistically significant. Therefore they are capturing different things and hence are interesting to look at.

Table 3.3: Correlation Matrix [2]

	Headcount ($2 at day)	*Headcount ($1.25 at day)*	*Poverty gap ($2 at day)*	*Poverty gap ($1.25 at day)*
Headcount ($1.25 at day)	0.966			
	(0.000)			
Poverty gap ($2 at day)	0.967	0.998		
	(0.000)	(0.000)		
Poverty gap ($1.25 at day)	0.877	0.962	0.970	
	(0.000)	(0.000)	(0.000)	
Poorest quintile	0.157	0.071	0.046	-0.078
	(0.017)	(0.285)	(0.484)	(0.239)

Notes: The table shows simple correlations between alternatives measure of poverty (*p*-values in parentheses).

Table 3.4 presents the matrix correlation for the proxies of financial development. The correlation between liquid liabilities and private credit is high and statistically significant. Similarly, stock market capitalization is significantly correlated with both liquid liabilities and private credit, though the coefficients are not too high. On the other hand, commercial central bank and, especially, turnover ratio are weakly correlated with the other indices of financial development. This should not be surprising as commercial central bank and turnover ratio are measures of efficiency and liquidity whereas the remaining indices are based mainly on the size of the financial sector.

Table 3.4: Correlation Matrix [3]

	Liquid liabilities	*Private credit*	*Commercial-central bank*	*Turnover ratio*
Private credit	0.821			
	(0.000)			
Commercial-central bank	0.329	0.456		
	(0.000)	(0.000)		
Turnover ratio	0.159	0.116	0.149	
	(0.047)	(0.148)	(0.054)	
Stock market capitalization	0.632	0.670	0.331	0.154
	(0.000)	(0.000)	(0.000)	(0.050)

Notes: The table shows simple correlations between the proxies for financial developments (*p*-values in parentheses).

Figures 3.1-3.10 in Appendix plot the time trend of the indices of poverty and the five proxies of financial development over the 1985-2008 period. As it can be seen, poverty as measured by the headcount and the gap indices have been volatile with a decreasing trend over time. The income share of the poorest quintile has fluctuated over time. Its average in 2008 (6.11%) is slightly higher than the corresponding average in 1985 (5.9%). Financial indices show an increasing time trend, though there are some differences. For example, the turnover ratio displays a remarkable variation over time, while other indices are characterized by a relatively smooth trend. Clearly, visual analysis cannot be used to draw any inference and panel estimations are needed to assess the impact of financial development on poverty.

3.5.2. Estimation Results

To assess the financial development-poverty nexus, I compute first several specifications of the empirical model, each focusing on a particular proxy of financial development. For a given index, I then proceed to run further regressions across different measures of poverty. The empirical estimates are shown in Tables 3.5-3.9. Specifically, columns 1 and 2 illustrate the impact of financial development on the share of the population earning less than $ 2 and $ 1.25 a day at 2005 international prices, respectively. Column 3 refers to the poverty gap computed at the $ 2 poverty line while column 4 shows the corresponding estimates for poverty gap associated with the cut-off

of $ 1.25. The final column illustrates the statistical results on the income share of the poorest quintile.

Starting the analysis from the set of controls, all tables show a significant impact of per capita GDP growth on poverty alleviation, irrespective of the poverty index. Such a finding provides evidence in favour of a pro-poor impact of growth, meaning that poverty alleviation and growth are likely to go hand in hand. This result is in line with several empirical studies, such as Dollar and Kraay (2002), Jalilian and Kirkpatrick (2005) and Kraay (2006).

The coefficient on primary education is never statistically significant in the regression with the headcount index or the poverty gap. On the other hand, in all but one specification (Table 3.9, column 5), primary education is statistically significant with a negative sign in the regressions with the poorest quintile as the dependent variable (Table 3.5-3.8, column 5). This means that a higher level of (primary) school enrolment decreases the share of the income received by the poorest quintile. This finding suggests that rising levels of primary education in poor countries benefit mostly the richer quintiles, thereby increasing their income share relatively to the lowest quintile. One possible reason is that an increase in primary school enrolment by the poor is not followed by an equivalent increase in secondary school because of the high opportunity cost of education in developing countries. As the payoff from primary school is low as compared with secondary school, most of the benefits associated with higher education levels will accrue only to those households who can allow their children to continue their studies.

Remarkably, the coefficients associated with inflation fail to achieve any conventional level of statistically significance. These estimates are somewhat surprising because one would expect inflation to hurt especially the poor. However, on the empirical side, the finding is in line with Dollar and Kraay (2002) and Jeanneney and Kpodar (2011) who also find little evidence for a statistically significant impact of inflation on poverty incidence. The lagged poverty term is positive and statistically significant for all specifications with a value less than one. This figure supports the choice of using dynamic panel techniques.

Public spending appears to be statistically insignificant, the only exception being the regression on the $2 per day poverty ratio with stock market capitalization as the proxy for financial development (Table 3.9 column 1). One possible explanation for this lack of statistical significance is that governments in developing countries devolve large share of public resources to expenditures which do not benefit the poor, such as military spending, while marginalizing pro-poor spending, such as expenditure for education and health. Another explanation is that public spending has no direct effect on poverty, yet it affects the poor indirectly, through the rate of economic growth. This finding is in line with Dollar and Kraay (2002) who show the impact of government consumption on the bottom quintile to be statistically insignificant.

The Gini coefficient is statistically significant with a positive sign in two of the regressions with private credit as a proxy for financial development (Table 3.6 column 2 and 3). The positive sign means that a widening in the income inequality distribution is conducive to an aggravation of poverty. However, lack of statistical significance of the Gini coefficient in other regressions casts doubt on the robustness of such finding. These estimates resemble Jeanneney and Kpodar (2011) who find no evidence for a statistically significant impact of inequality in land distribution on the poor.

Overall, the quality of institutions seems to have no significant impact on poverty. It is possible that the effects of institutional reforms, such as lower levels of corruption and a more efficient bureaucracy benefit principally the rich as well as the middle class. An alternative explanation might be that the benefit for the poor is offset, at least in the short term, by transaction costs entailed by institutional reforms which affect the informal sector. On the empirical front, these findings are in line with Honohan (2004) who also finds little evidence that institutional quality has a statistically significant impact on poverty rate.

The *p*-values of the Sargan test and the Arellano-Bond test are displayed in Panel B. As can be seen, in no case does the Sargan test invalidate the set of instruments used in the estimation. Further, serial correlation of order 2 in the error term can be rejected in all specifications.

One can wonder whether these results are partially driven by the causal relationship running in the opposite direction, from poverty to financial development. However, the poor in developing countries are unlikely to hold a significant share of financial assets (Honoan, 2004). On the empirical side, using a Granger causality test for a sample of 35 countries, Perez-Moreno (2011) provides little evidence for a reversal effect from financial development to poverty. Thus, unlike the finance-growth nexus, the problem of reverse causality should not be severe for the relationship between poverty and financial development, at least within four year-intervals. An additional source of concern in panel data is the presence of unit roots. Because of the small time series dimension of the data (up to six periods), it is not possible to run formal test. Given that system GMM estimator takes first differences and that most economic series are stationary in first differences, one can be reasonably confident that the estimates are not reflecting a spurious relationship.

Liquid Liabilities to GDP ratio

Table 3.5 displays the empirical findings concerning liquid liabilities as a proxy of financial development. Specifically, column 1 shows that the coefficient associated with liquid liabilities is statistically significant with a negative sign, just missing the 0.5 confidence level (*p*-value: 0.052). Taken at face value, the coefficient implies that a one-standard deviation increase in liquid liabilities (by 0.25 in the overall time period 1985-2008) is estimated to lower the poverty rate by 0.01 (1%).[5] Using the poverty line of $ 1.25 a day confirms the statistical and economic significance of the impact of financial development on poverty.

Columns 3-4 show that the choice of a different index of absolute poverty, namely poverty gap, does not affect the empirical estimates. This means that financial development reduces not only the incidence of poverty but also its depth. On the other hand, the coefficient of liquid liabilities fails to reach any conventional level of statistical significance when the income share of the poorest 20% of population is used as a measure of poverty (column 5). This finding suggests that, unlike absolute poverty,

[5] This figure has been obtained as the difference between two fitted values of the headcount index. The first value is the product between the estimated coefficient $\hat{\gamma}$ and the average of liquid liabilities (0.40). The second value is computed by multiplying $\hat{\gamma}$ by the sum of the average and standard deviation of liquid liabilities (0.40 + 0.25).

relative poverty is unaffected by a rising level of liquid assets. In other words, the share of the income accruing to the lowest quintile has neither increased nor decreased as a result of an increase in the size of the financial sector.

Table 3.5: System GMM Estimates for Financial Development Effect - Liquid Liabilities to GDP

Panel A: Estimation Results					
	[1]	[2]	[3]	[4]	[5]
	Headcount ($2 per day)	Headcount ($1.25 per day)	Poverty gap ($2 per day)	Poverty gap ($1.25 per day)	Poorest quintile
y_{t-1}	0.951***	0.866***	0.872***	0.810***	0.883***
	(0.033)	(0.044)	(0.041)	(0.048)	(0.046)
Liquid liabilities$_t$	-0.045*	-0.052*	-3.755*	-3.724***	0.210
	(0.022)	(0.027)	(1.900)	(1.064)	(0.398)
Institutions$_t$	0.012	0.016	0.990	1.068**	0.031
	(0.012)	(0.015)	(0.775)	(0.430)	(0.106)
Growth$_t$	-0.009**	-0.006*	-0.426*	-0.340**	0.057*
	(0.004)	(0.003)	(0.251)	(0.142)	(0.030)
Inflation$_t$	-0.000	-0.000	-0.001	-0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
Gini$_t$	0.001	0.001	0.052	0.023	
	(0.001)	(0.001)	(0.083)	(0.052)	
Public spending$_t$	0.001	0.001	0.052	0.069	-0.014
	(0.003)	(0.003)	(0.151)	(0.098)	(0.024)
Education$_t$	-0.000	-0.001	-0.026	-0.016	-0.013*
	(0.000)	(0.001)	(0.044)	(0.052)	(0.007)
Constant	-0.028	-0.029	-2.027	-1.877	1.784**
	(0.080)	(0.093)	(7.408)	(6.238)	(0.877)
Panel B: Diagnostic Tests					
AR(2)	0.696	0.343	0.290	0.177	0.844
Hansen test	0.686	0.391	0.383	0.661	0.764
Observations	155	155	155	155	158
Countries	53	53	53	53	54
Instruments	28	28	28	28	40

Notes: The table shows the main determinants of poverty. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. All regressions include a set of time dummy variables. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

These findings are in line with Akther *et al*. (2010) who use a fixed effect vector decomposition to estimate the financial development-poverty nexus. The results are also in line with Jeanneney and Kpodar (2011) who provide evidence for a significantly

negative impact of broad liquidity on the poverty rate (headcount index) using system GMM. However, contrary to Jeanneney and Kpodar (2011), my results yield little support for a poverty alleviation effect of financial development when poverty is proxied by the poorest income share. Such variety in results might be explained by differences in model specification, sample size and time coverage. These dissimilarities are discussed in more detail in the next section where the value of credit granted to the private sector is used as proxy of financial development.

Credit to Private Sector to GDP ratio

The estimation results regarding the amount of credit offered by financial intermediaries to private sector are illustrated in Table 3.6. As can be seen in column 1, the estimated coefficient of private credit is negative, which indicates that a higher level of credit to the private sector predicts lower poverty levels. Specifically, the estimate suggests that an increase in credit to the private sector by 0.26 (its standard deviation in the 1985-2008 period) would decrease the poverty rate by 0.01 (1%).[6] The *p*-value associated with the coefficient is 0.09, which is just below the 10% level of confidence. Thus, the coefficient is only marginally significant. However, the statistical significance of credit to private sector is preserved across alternative measures of absolute poverty (columns 2-4).

These findings are generally in line with Honohan (2004), Beck *et al*. (2007) and Akter *et al*. (2010). On the other hand, the effect of private credit on poverty alleviation is in contrast with Jeanneney and Kpodar (2011) who document a statistically insignificant impact of private credit on the headcount index. One plausible explanation for such a variety in results is differences in specification. Jeanneney and Kpodar (2011) do not include the lagged dependent variable in their set of regressors. However, the empirical model used here shows that lagged poverty is highly significant, its coefficient ranging from 0.95 to 0.77. Thus, failing to include lagged poverty on the right hand side is likely to be a source of omitted variable bias.[7]

[6] See footnote 5 for how this figure has been calculated.

[7] It has to be acknowledged that Jeanneney and Kpodar (2011) include the lagged dependent variable on the right hand side when running the regression with the poorest quintile as the dependent variable. The estimated coefficient in their regression is statistically significant, ranging from 0.35 to 0.53.

Table 3.6: System GMM Estimates for Financial Development Effect - Private Credit to GDP

Panel A: Estimation Results					
	[1]	[2]	[3]	[4]	[5]
	Headcount ($2 per day)	Headcount ($1.25 per day)	Poverty gap ($2 per day)	Poverty gap ($1.25 per day)	Poorest quintile
y_{t-1}	0.908***	0.855***	0.868***	0.769***	0.815***
	(0.030)	(0.040)	(0.036)	(0.064)	(0.062)
Private credit$_t$	-0.040*	-0.036*	-2.640*	-2.643*	0.082
	(0.024)	(0.021)	(1.416)	(1.469)	(0.321)
Institutions$_t$	0.006	0.002	0.327	0.408	-0.044
	(0.009)	(0.012)	(0.830)	(0.869)	(0.106)
Growth$_t$	-0.007***	-0.005**	-0.383**	-0.248*	0.076**
	(0.002)	(0.002)	(0.162)	(0.142)	(0.034)
Inflation$_t$	-0.000	-0.000	-0.001	-0.004	0.000
	(0.000)	(0.000)	(0.001)	(0.007)	(0.001)
Gini$_t$	0.001	0.002**	0.090*	0.058	
	(0.001)	(0.001)	(0.048)	(0.042)	
Public spending$_t$	-0.002	0.000	0.015	-0.008	0.030
	(0.002)	(0.002)	(0.113)	(0.124)	(0.020)
Education$_t$	-0.000	-0.001	-0.030	-0.016	-0.019**
	(0.000)	(0.001)	(0.040)	(0.040)	(0.009)
Constant	0.009	-0.007	-1.114	-0.753	2.608**
	(0.046)	(0.066)	(5.517)	(4.690)	(1.069)
Panel B: Diagnostic Tests					
AR(2)	0.430	0.239	0.242	0.105	0.680
Hansen test	0.592	0.699	0.644	0.504	0.390
Observations	154	154	154	154	157
Countries	53	53	53	53	54
Instruments	52	44	44	51	40

Notes: The table shows the main determinants of poverty. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. All regressions include a set of time dummy variables. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Different samples might be also relevant for explaining contrasting results. Jeanneney and Kpodar focus on a larger number of countries (65) than my study, yet the overall number of observations is relatively small (121), which indicates that the coverage of their dataset is particularly scant.[8] Further, their analysis covers the period from 1980-2000 which is different from the time span analysed by this study. In line with

[8] It should be noted that the sample of countries used by Jeanneney and Kpodar (2011) increases to 75 countries and 187 observations when the dependent variable is the poorest quintile.

Jeanneney and Kpodar (2011), Perez-Moreno (2011) also provides little evidence for an impact of private credit on poverty. However his study relies on a relatively small sample of country (35) with observations separated by not less than 8 years over the period 1970-1998.

Finally, according to the last column of Table 3.6, private credit turns out to be statistically insignificant when the bottom quintile is used as the regressand. This specific result is in line with Jeanneney and Kpodar (2011) who also find little evidence for a statistically significant impact of private credit on the poorest quintile. On the other hand, this finding is in contrast with Jalilian and Kirkpatrick (2005) and Beck *et al*. (2007) who find empirical evidence of a positive and statistically significant impact of private credit on the income share of the poorest quintile. Differences in econometric techniques and sample composition might be at the core of these contrasting results. These are discussed in more detail in the next section.

Ratio of Commercial Bank to Central Bank Assets

Table 3.7 displays the estimated relationship between poverty and the commercial to central bank assets ratio. Remarkably, the sign of the corresponding coefficient varies across difference specifications of absolute levels of poverty (columns 1-4). However, the coefficient fails to reach statistical significance at any conventional level, whatever the measure of poverty. This means that the extent to which commercial financial intermediaries allocate savings relative to central banks has no sensible (direct) effect on the poverty rate.[9]

[9] Lack of statistical significance does not imply that a variable has no impact on poverty. For example, commercial-central bank might lead to poverty alleviation indirectly, by increasing the growth rate of an economy. Empirical works, such as King and Levine (1993) and Beck *et al*. (2000), provide evidence for a growth-enhancing impact of this variable.

Table 3.7: System GMM Estimates for Financial Development Effect - Commercial-Central Bank Assets ratio

Panel A: Estimation Results					
	[1]	[2]	[3]	[4]	[5]
	Headcount ($2 per day)	Headcount ($1.25 per day)	Poverty gap ($2 per day)	Poverty gap ($1.25 per day)	Poorest quintile
y_{t-1}	0.913***	0.846***	0.881***	0.812***	0.849***
	(0.032)	(0.031)	(0.043)	(0.059)	(0.057)
Commercial-central bank$_t$	-0.059	-0.029	0.925	1.127	-0.787
	(0.052)	(0.052)	(3.512)	(3.727)	(0.496)
Institutions$_t$	-0.005	0.001	-0.200	-0.355	0.011
	(0.009)	(0.007)	(0.428)	(0.473)	(0.121)
Growth$_t$	-0.006**	-0.004**	-0.465*	-0.280*	0.049**
	(0.003)	(0.002)	(0.258)	(0.163)	(0.023)
Inflation$_t$	0.000	0.000	-0.000	-0.001	-0.000
	(0.000)	(0.000)	(0.002)	(0.002)	(0.000)
Gini$_t$	0.001	0.000	-0.088	-0.041	
	(0.002)	(0.001)	(0.106)	(0.091)	
Public spending$_t$	-0.000	-0.001	-0.158	-0.097	0.004
	(0.003)	(0.003)	(0.115)	(0.104)	(0.023)
Education$_t$	0.001	0.000	0.038	0.016	-0.021**
	(0.001)	(0.001)	(0.062)	(0.048)	(0.010)
Constant	-0.048	-0.031	2.439	2.624	3.543**
	(0.106)	(0.082)	(3.348)	(3.382)	(1.346)
Panel B: Diagnostic Tests					
AR(2)	0.489	0.653	0.347	0.370	0.993
Hansen test	0.291	0.391	0.705	0.653	0.481
Observations	166	166	166	166	169
Countries	59	59	59	59	60
Instruments	44	36	43	51	53

Notes: The table shows the main determinants of poverty. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. All regressions include a set of time dummy variables. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Similarly, the coefficient of commercial-central bank turns statistically insignificant when the poorest quintile is the dependent variable (column 5). This result is in line with Dollar and Kraay (2002) who also uses system GMM estimator to estimate the impact of commercial-central bank assets on the poorest quintile.[10] On the other hand, my findings are in contrast with Beck *et al.* (2007) and Jalilian and Kirkpatrick (2005) who show a significant impact of commercial-central bank ratio on the poorest

[10] The main focus of Dollar and Kraay (2002) is on growth rather than financial development.

quintile.[11] Such divergence in results is likely to be due to differences in econometric techniques. Specifically, Beck *et al.* run a pure cross-sectional analysis using standard OLS. However, there are some econometric issues, such as simultaneity bias and omitted variables, including unobserved country-specific characteristics that cross-section regressions fail to account for. Further, cross-section estimations ignore the time series dimension of the data, thereby discarding an important source of information for inference analysis.[12]

Another possible reason underlying the difference of results might be the composition of the sample. Specifically, while my investigation focuses on developing countries only, the sample investigated by Beck *et al.* (2007) and Jalilian and Kirkpatrick (2005) also includes advanced economies. However, as explained in section 3.3, combining developed and developing countries in the same sample can introduce a strong element of heterogeneity. The presence of developed economies could be a driving force behind their results.

Capital Market Development

The results for the last two proxies for financial development are shown in Table 3.8 and 3.9. As can be seen from Table 3.8, the estimates of the turnover ratio indicate that more liquid stock markets are associated with higher (absolute) poverty (columns 1-4). The coefficients turn out to be negative in the regression on relative poverty (column 5). These results suggest that higher levels of liquidity in the stock market are somehow detrimental for the poorest. However, in no specification does the variable achieve conventional levels of statistical significance. Table 3.9, column 1 shows that the coefficient associated with stock market capitalization has a negative sign, but again, the impact is statistically insignificant. This finding is robust across different indices of poverty (columns 2-5).

[11] It has to be noted that, in line with my estimations, Beck *et al.* (2007) provide no evidence for a significant relationship between commercial-central bank and the headcount poverty index.
[12] It has to be acknowledged that Beck *et al.* (2007) also use system GMM to assess the impact of private credit on poverty. However, they use simple OLS regression when moving on commercial-bank ratio as an index of financial development.

Table 3.8: System GMM Estimates for Financial Development Effect - Turnover ratio

Panel A: Estimation Results					
	[1]	[2]	[3]	[4]	[5]
	Headcount ($2 per day)	Headcount ($1.25 per day)	Poverty gap ($2 per day)	Poverty gap ($1.25 per day)	Poorest quintile
y_{t-1}	0.891***	0.847***	0.911***	0.778***	0.811***
	(0.064)	(0.089)	(0.069)	(0.061)	(0.114)
$Turnover_t$	0.043	0.023	0.264	1.069	-0.461
	(0.029)	(0.029)	(1.501)	(1.116)	(0.453)
$Institutions_t$	-0.012	-0.009	-0.501	-0.402	-0.338
	(0.010)	(0.012)	(0.487)	(0.422)	(0.208)
$Growth_t$	-0.013**	-0.010**	-0.582**	-0.272*	0.120**
	(0.005)	(0.004)	(0.256)	(0.149)	(0.050)
$Inflation_t$	-0.000	0.000	0.001	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$Gini_t$	0.001	-0.000	0.021	0.026	
	(0.002)	(0.001)	(0.076)	(0.054)	
Public	0.003	0.003	0.108	-0.005	0.000
	(0.002)	(0.004)	(0.173)	(0.154)	(0.058)
$Education_t$	-0.001	-0.001	-0.038	-0.011	-0.047**
	(0.000)	(0.000)	(0.033)	(0.030)	(0.020)
Constant	0.068	0.098	5.095	2.957	7.099**
	(0.082)	(0.072)	(5.144)	(4.016)	(2.967)
Panel B: Diagnostic Tests					
AR(2)	0.571	0.880	0.910	0.729	0.180
Hansen test	0.442	0.181	0.165	0.270	0.721
Observations	122	122	122	122	125
Countries	42	42	42	42	43
Instruments	36	28	36	36	39

Notes: The table shows the main determinants of poverty. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. All regressions include a set of time dummy variables. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

These results suggest that the development of stock market, either as measured by size or degree of liquidity, has played no significant role in poverty alleviation. These findings are in line with Honoanh (2004) who also provides no evidence for a statistically significant impact of turnover ratio and stock market capitalization on poverty rate. One possible explanation for such a lack of statistical significance is that, contrary to the banking sector, the development of capital market is irrelevant for poverty reduction. An alternative reason for this result is that equity markets simply are

not sufficiently developed in low and middle-income countries to have any significant impact on poverty.[13]

Table 3.9: System GMM Estimates for Financial Development Effect - Stock Market Capitalization

Panel A: Estimation Results					
	[1]	[2]	[3]	[4]	[5]
	Headcount ($2 per day)	Headcount ($1.25 per day)	Poverty gap ($2 per day)	Poverty gap ($1.25 per day)	Poorest quintile
y_{t-1}	0.937***	0.888***	0.903***	0.846***	0.830***
	(0.035)	(0.037)	(0.039)	(0.074)	(0.115)
Stock market capitalization$_t$	-0.002	-0.011	-0.774	-0.510	-0.175
	(0.030)	(0.014)	(1.034)	(0.955)	(0.672)
Institutions$_t$	-0.009	-0.003	-0.191	0.033	-0.291
	(0.011)	(0.005)	(0.323)	(0.300)	(0.185)
Growth$_t$	-0.013**	-0.009***	-0.604**	-0.380*	0.116**
	(0.006)	(0.003)	(0.244)	(0.214)	(0.057)
Inflation$_t$	0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Gini$_t$	0.000	0.000	0.016	0.001	
	(0.002)	(0.001)	(0.085)	(0.081)	
Public spending$_t$	0.004**	0.003	0.164	0.067	-0.014
	(0.002)	(0.002)	(0.178)	(0.132)	(0.054)
Education $_t$	-0.001	-0.001	-0.038	0.002	-0.033
	(0.001)	(0.001)	(0.050)	(0.052)	(0.044)
Constant	0.064	0.064	3.643	0.617	5.517
	(0.068)	(0.074)	(4.365)	(2.301)	(5.586)
Panel B: Diagnostic Tests					
AR(2)	0.782	0.547	0.575	0.553	0.189
Hansen test	0.269	0.424	0.281	0.284	0.628
Observations	116	116	116	116	119
Countries	41	41	41	41	42
Instruments	36	36	36	36	32

Notes: The table shows the main determinants of poverty. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. All regressions include a set of time dummy variables. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

[13] By comparing the number of observations across alternative indices of financial development, it can be seen that the number of countries drops dramatically when either stock market capitalization or liquidity ratio is used. The reason is that these proxies include only countries with equity markets. Several countries, particularly the small and low-income ones, lack any stock market (Beck and Demirgüç-Kunt, 2009).

Discussion

The results have provided evidence that financial development, as proxied by the depth of the banking sector, seems to be neutral in terms of relative poverty. On the other hand, financial development appears to effectively relieve absolute poverty. Given the aggregate nature of the proxies of financial development, the current analysis does not allow us to be specific about the financial policies which should be carried in order to effectively tackle poverty. Traditional examples of policies which expand the banking sector are the liberalization of interest rates and the removal of reserve requirements. However, as illustrated by Arestis *et al*. (2002) these financial policies do not always foster financial development. Specifically, using an Error Correction Model, the authors estimate the relationship between financial development, as proxied by liquid liabilities, and a number of policy variables including reserve requirements and interest rate restraints for a sample of 6 countries. According to their findings, the effects of financial liberalization are mixed. Specifically, they show that for some countries financial restraints have fostered financial development.

An additional example of financial policies is the 1:4 license rule adopted in India between 1977 and 1990. Under this rule, a commercial bank could have opened an additional branch in a location with bank presence only if it opened four branches in locations devoid of banks. It has been estimated that such policy boosted the creation of new branches in 30000 rural areas. Burgess and Pande (2005) have used this policy as a natural experiment to assess the impact on poverty of bank expansion in rural areas. Their study show that poverty incidence declined faster in areas which previously lacked bank access. Specifically, they find that a one per cent raise in the number of banks in rural areas has lowered poverty by 0.36 per cent.

To sum up, my study suggests that financial development might alleviate poverty, though it does not seem to favour disproportionately the poor. Previous analyses based on case studies suggest that the specific set of financial policies to adopt depends greatly on the context within which the financial sector works.

3.5.3. Financial Crisis

One of the major financial events occurred during the time period under study is the crisis experienced by Southeast Asia in the years 1997 and 1998. As the poor are likely to be particularly vulnerable to financial turmoil, the empirical analysis should account for such events. One way to do so is to include time dummies in the set of control variables. As it has been explained in section 3.3.1, the right hand side of the regression contains time dummies for each of the four year- intervals within the time period 1985-2000.[14] Thus, it is interesting to have a look to the variable taking value of 1 for the period 1997-2000 to gain possible insights about the impact of the 1997-1998 financial crisis.

The coefficient of the 1997-2000 time variable is statistically significant at the 10% level for the regression on the $ 2 a day headcount with commercial-central bank as proxy for financial development (results now shown here). The magnitude is approximately 0.3 and the sign is positive which means that poverty incidence is indeed increased in this four-year interval. However, this finding is far from being robust because of the lack of statistically significance of the 1997-2000 time variable in all the other regressions (results available upon request). Such results are somewhat surprising because one would expect the poor to have been particularly hurt by the 1997-1998 financial crisis. One plausible explanation is that the events occurred in 1997 and 1998 were limited to the East Asian countries whereas the sample under study include all but the high-income countries. In fact, the empirical analysis could tell a different story if the on-going financial crisis which started in 2008 was accounted for in the estimation. The main difference with the 1997-1998 crises is that the current financial crisis has turned to be a major worldwide recession. Unfortunately, the panel data in this study covers the time period up to 2008, which make impossible any empirical investigation of the 2008-onward crisis. This could be carried in a future analysis as additional data become available.

[14] Please note that the construction of the panel data in six non-overlapping four-year intervals makes it impossible to generate a specific variable for the two consecutive years 1997 and 1998.

3.5.4. Robustness Check

The empirical findings might be driven by the presence of specific observations which have an unusual effect on the estimates. Thus, as a robustness check, I have investigated the observations associated with relatively large residuals. These are specifically the point observations that are greatly overpredicted (or underpredicted) by the model. A graphical inspection detects different potential outliers depending on the specification. Thus, I excluded such observations from the sample and re-run estimations (results not shown).

With regard to the indices of liquid liabilities, commercial-central bank and private credit, the observations which appear as outliers in most of the regressions on absolute poverty are Gambia 2001-2004 and Honduras 1989-1992. Remarkably, once these observations are excluded from the sample, the coefficient of liquid liabilities in the regression using the $ 2 a day headcount index turns out to be statistically insignificant (*p*-value: 0.11). On the other hand, the statistical significance of liquid liabilities is preserved across the other three specifications (the statistical significance raises to the 5% level of confidence for the $1.25 poverty line).

The exclusion of such observations has no qualitative effect on the coefficient of private credit, which remains statistically significant, neither does it have any effect on the coefficient of commercial-central bank, which continues to show no significant impact on absolute poverty. Similarly, dropping the outliers does not affect the estimates associated with the poorest quintile, which continues to lack statistical significance.[15] Similarly, the empirical findings concerning the indices of stock market development (turnover ratio and stock market capitalization) are not affected by the omission of outliers.[16] Thus, lack of evidence for a significant impact of stock market development is not driven by observations which are poorly predicted by the model.

[15] Malawi 2001-2004 and Paraguay 1993-1996 are common outliers to most of the regressions where the poorest quintile is the dependent variable.

[16] When using the indices of development of stock market, the observations which results as outliers in most of the regressions are Bolivia 1997-2000, Guatemala 2001-2004 and Zambia 2001-2004, 2005-2008.

3.5.5. Results from alternative estimation techniques

In this section I proceed to run different estimation methods, namely OLS, FE and RE estimators and first-difference GMM. Because of the drawbacks from employing these techniques in the present context, it is not surprising that the respective estimates might differ substantially from those obtained by using system GMM.[17] Such additional estimators have been used exclusively for illustrative purposes. I have done such exercise for the regression having the headcount ratio ($2 per day) as dependent variable and liquid liabilities as proxy for financial development. The results are shown in Table B.3. Column 5 of Table B.3 replicates the estimates from system GMM (column 1 of Table 3.5).

As it can be seen, both the sign and statistical significance of the coefficients associated with economic growth and liquid liabilities are preserved under OLS and RE estimators. On the other hand, both variables turn to be statistically insignificant when FE estimator or first-difference GMM is used.[18] One possible explanation behind such lack of statistically significance is that both estimators drop cross-country variation, thereby discarding an important source of information. Another reason is that mean-differencing (FE) as well as first-differencing (first-difference GMM) intensifies measurement errors (Griliches and Hausman, 1986). The tables show that the lagged dependent variable, $Pov_{i,t-1}$, results statistically significant with a positive sign regardless of the estimation technique. Yet the size of the coefficient is considerably smaller under FE. This is precisely what one would expect because FE estimator yields an estimate of $Pov_{i,t-1}$ that is seriously downward biased in panel with many cross-sections for relatively few time periods (Nickell, 1981). As regards for first-difference GMM, the relative small size of $Pov_{i,t-1}$ is probably due to the weak instruments problem that affects such technique in presence of highly persistent variables (Blundell and Bond, 1998).

[17] See Chapter One for more details on the methodological difficulties which characterize alternative estimation approaches (pp. 24-27).

[18] When comparing the number of observations across alternative techniques, it can be seen that first-difference GMM drastically reduces the size of the sample. The reason is that the first observation for each unit is lost from first-differencing (the countries which have only two observations are dropped). The same does not occur for system GMM because, as explained in section 3.3.2, in addition to the equation in difference, this technique also uses an equation in levels.

3.6. Conclusions

Previous empirical studies have generally provided evidence of a beneficial impact of financial development in favour of the poorest. The aim of this study is to reassess the causal link from financial development to poverty for a sample of developing countries using alternative measures of poverty as well as a large array of indices of financial development.

The main results from this empirical investigation can be summarized as follows. The empirical evidence of a relationship between financial development and poverty primarily depends on the nature of the poverty index used. I find some evidence in favour of a mitigating effect of financial development on the poor when poverty is measured by the headcount index or the poverty gap at the cut-off line of $ 2 day (absolute poverty). Thus, financial development is likely to reduce the incidence as well as the depth of poverty. This finding is robust to the choice of a more conservative poverty line based on $ 1.25 a day. On the other hand, the results show that financial development does not appear to benefit disproportionately those at the lower end of distribution (relative poverty). Thus, financial development appears to be neither "regressive" nor "progressive".

The results also suggest that evidence of a beneficial effect of financial development on the poor is sensitive to the proxy of financial development. When financial development is gauged by the size of the banking sector (as proxied by the value of liquid liabilities and the value of the credit provided by financial intermediaries to private, both as a share of GDP), the estimates corroborate a pro-poor effect of financial development. On the other hand, when indices of the size/liquidity of the stock markets are used (proxied by stock market capitalization and turnover ratio) the results provide no support in favour of a pro-poor effect of financial development. Similarly, the relative degree to which credit is being allocated by commercial banks vis-à-vis central banks has no statistically significant impact on poverty.

These findings carry some important insights for policy makers in developing countries. My results suggest that, unlike stock market reforms, banking sector reforms that

promote financial development may be an effective instrument to tackle absolute levels poverty. On the other hand, the policy maker should not rely on financial development to narrow the gap between the poorest quintile and the richer fractions of the population. In this regard, fiscal policies, such as progressive taxation and public-expenditure projects which redistribute resources from the wealthy to the poor, should not be replaced by policies which foster financial development.

3.7. Appendix B

Table B.1: List of Countries

Albania	Guatemala	Niger
Argentina	Guyana	Nicaragua
Armenia	Honduras	Pakistan
Azerbaijan	Indonesia	Panama
Burkina Faso	Iran	Peru
Bangladesh	Jamaica	Philippines
Bulgaria	Jordan	Paraguay
Belarus	Kazakhstan	Romania
Bolivia	Kenya	Russia
Brazil	Sri Lanka	Senegal
China	Latvia	Thailand
Cote d'Ivoire	Morocco	Tunisia
Cameroon	Moldova	Turkey
Colombia	Madagascar	Uganda
Costa Rica	Mexico	Ukraine
Dominican Republic	Mali	Uruguay
Ecuador	Mongolia	Venezuela
Egypt	Mozambique	Vietnam
Ghana	Malawi	South Africa
Gambia	Malaysia	Zambia

Notes: The table illustrates the largest sample of countries used in the empirical investigation.

Table B.2: Description of Variables

Variable	Description	Source
Headcount ($ 2)	Share of the population living on less than $ 2 per day at 2005 PPP	World Development Indicator (World Bank)
Headcount ($ 1.25)	Share of the population living on less than $1.25 per day at 2005 PPP	
Poverty gap ($ 2)	Mean shortfall from the poverty line of $ 2 per day measured as a share of the poverty line	
Poverty gap ($ 1.25)	Mean shortfall from the poverty line of $ 1.25 per day measured as a share of the poverty line	
Poorest quintile	Income share earned by lowest 20%	
Growth	Percentage change of per capita GDP per capita based on constant local currency	
Inflation	Percentage change in the consumer price index	
Gini	Ratio of the area between the Lorenz curve and the line representing perfect equality	
Public spending	General government final consumption expenditure as a share of GDP	
Education	Primary school enrolment (% gross)	
Investment	Gross capital formation (%GDP)	
Openness	Sum of exports and imports to GDP ratio	
Population	Total population	
Liquid liabilities	Currency plus demand and interest-bearing liabilities of bank and other financial intermediaries as a share of GDP	Financial Structure Database 2010
Private credit	Credit to the private sector by financial institutions as a share of GDP	
Commercial-central bank	Claims of commercial banks on non-financial domestic sectors to the claims of central banks	
Turnover ratio	Value of the total shared traded to stock market capitalization ratio	
Stock market capitalization	Value of the listed share as a share of GDP	

(*continues*)

Table B.2 (*Continued*)

Institutions	Arithmetic average of the ICRG variables "Corruption", "Law and Order" and "Bureaucracy Quality"	International Country Risk Guide
Legal origin	Legal origin dummy for English, French, Socialist German and Scandinavian	La Porta *et al*.1999
Ethnic	Index of ethnic fractionalization	Alesina *et al*. 2003
Oil exporter	Dummy for oil exporter country	Global Development Network
Tropic	Dummy for tropical country	

Notes: Data on Institutions, legal origin and ethnic have been retrieved from Teorell, Jan, Marcus Samanni, Sören Holmberg and Bo Rothstein (2011). *The Quality of Government Dataset*, version 6Apr11. University of Gothenburg: The Quality of Government Institute [access via: http://www.qog.pol.gu.se.].

Table B.3: Robust two-step System GMM estimates for Liquid liabilities effect on the Headcount ($2 per day)

	Panel A: Estimation results				
	[1]	[2]	[3]	[4]	[5]
	OLS	FE	RE	DIF-GMM	SYS-GMM
y_{t-1}	0.907***	0.347***	0.888***	0.598**	0.951***
	(0.023)	(0.110)	(0.031)	(0.268)	(0.033)
Liquid liabilities$_t$	-0.035*	-0.065	-0.043*	-0.042	-0.045*
	(0.018)	(0.096)	(0.023)	(0.083)	(0.022)
Insitutions$_t$	-0.006	-0.003	-0.003	0.006	0.012
	(0.006)	(0.007)	(0.006)	(0.012)	(0.012)
Growth$_t$	-0.007***	0.000	-0.007***	-0.003	-0.009**
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
Inflation$_t$	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gini$_t$	0.000	0.003	0.001	0.004	0.001
	(0.001)	(0.002)	(0.001)	(0.004)	(0.001)
Public spending$_t$	0.000	0.004	0.001	0.005	0.001
	(0.001)	(0.003)	(0.002)	(0.004)	(0.003)
Education$_t$	0.000	0.000	-0.000	-0.001	-0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Constant	0.065	0.075	-0.005	0.008	-0.028
	(0.057)	(0.124)	(0.052)	(0.179)	(0.080)
	Panel B				
Observations	155	155	155	96	155
Countries	53	53	53	41	53
R^2	0.949	0.809	0.949		
Wald Statistic			196.247	161.266	

Notes: Panel A reports the estimates obtained from robust OLS, FE, RE, two-step difference GMM and system GMM estimators. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Panel B reports the overall number of observations, the number of countries, the R-squared and the Wald Statistic. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Figure 3.1: Plots of the Headcount Index ($2 at day) over 1985-2008

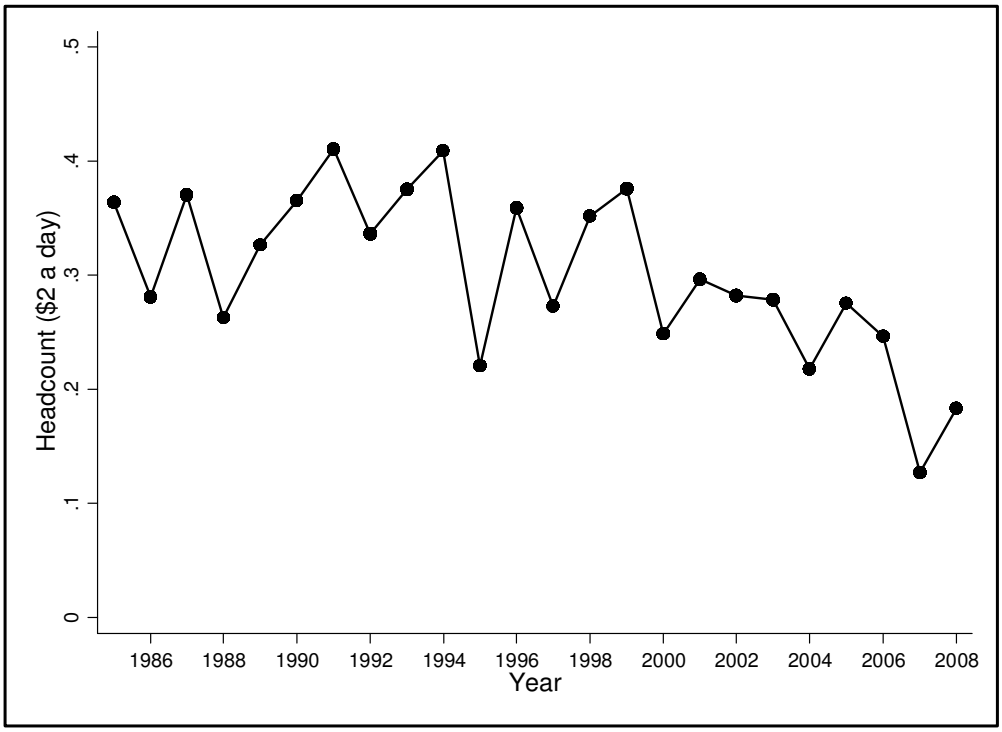


Figure 3.2: Plots of the Headcount Index ($1.25 at day) over 1985-2008

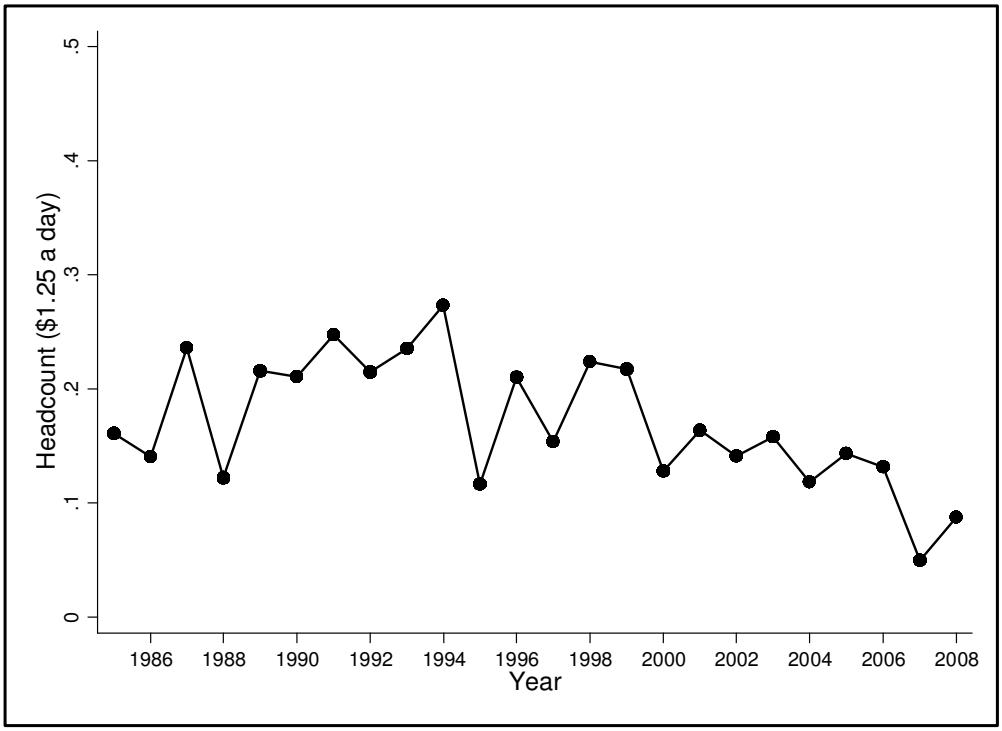


Figure 3.3: Plots of the Poverty Gap ($2 at day) over 1985-2008

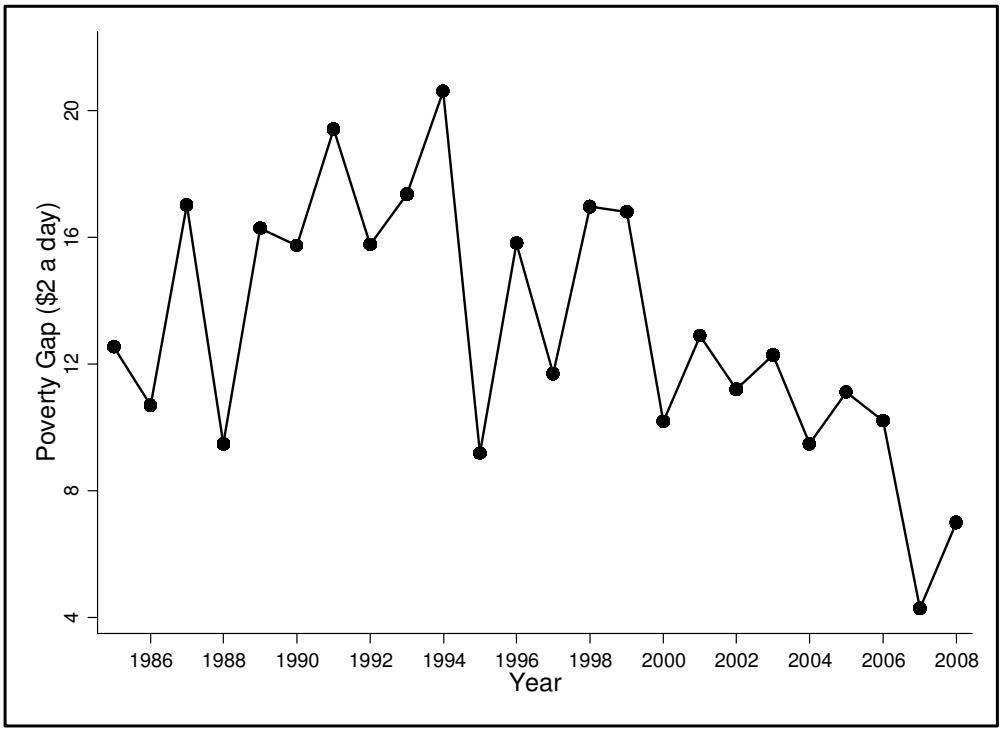


Figure 3.4: Plots of the Poverty Gap ($1.25 at day) over 1985-2008

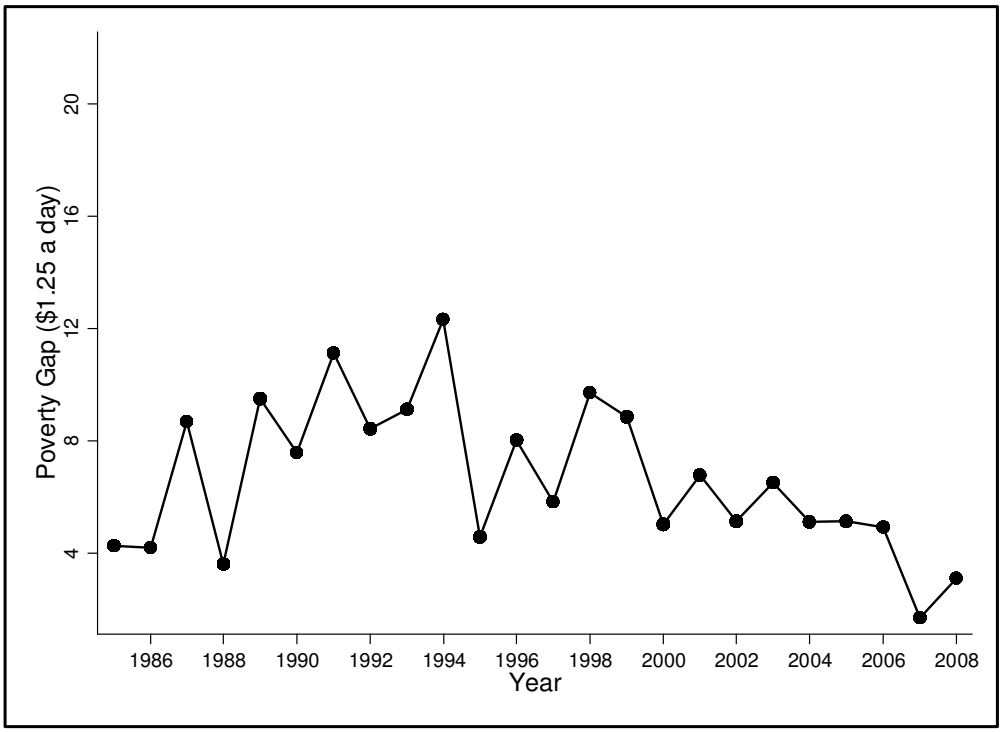


Figure 3.5: Plots of the Poorest Quintile over 1985-2008

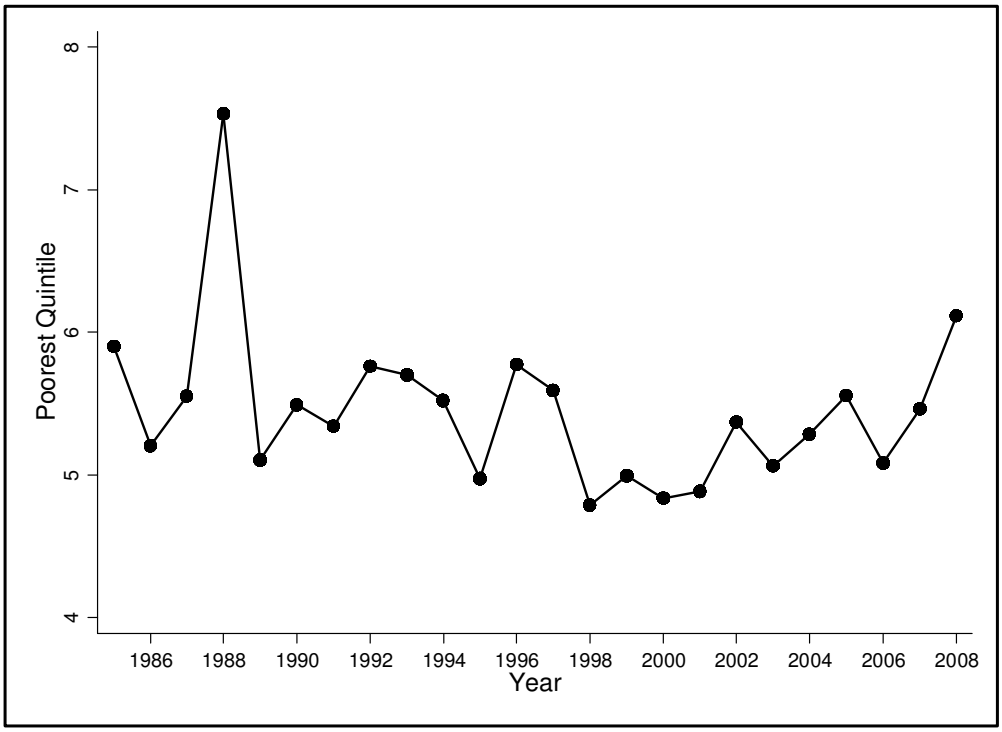


Figure 3.6: Plots of Liquid Liabilities over 1985-2008

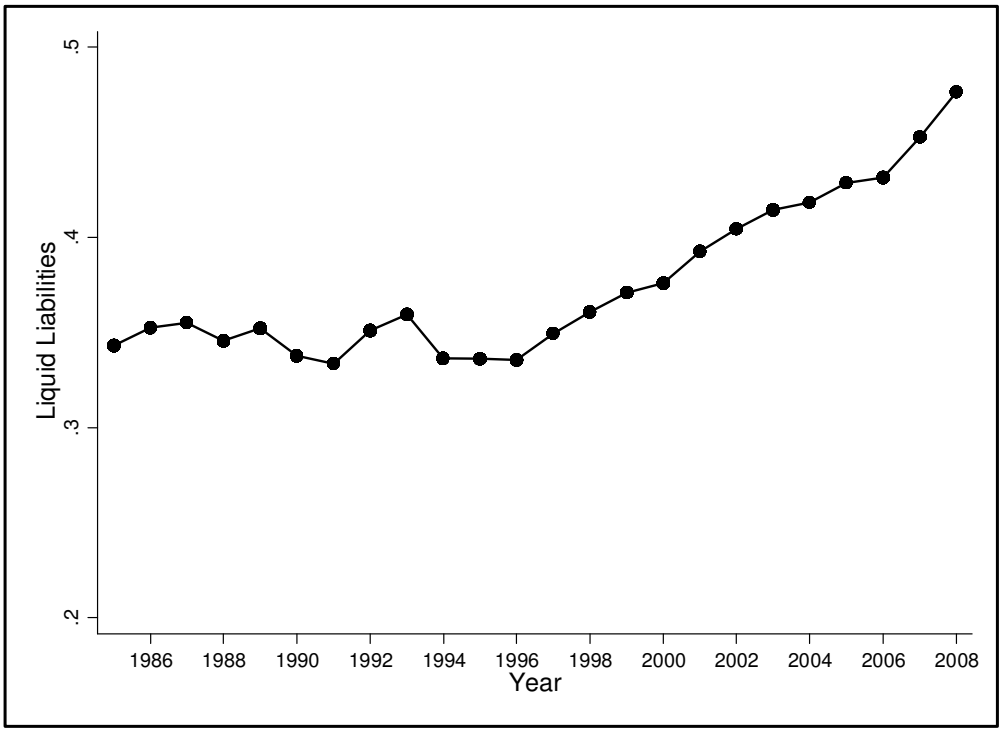


Figure 3.7: Plots of Private Credit over 1985-2008

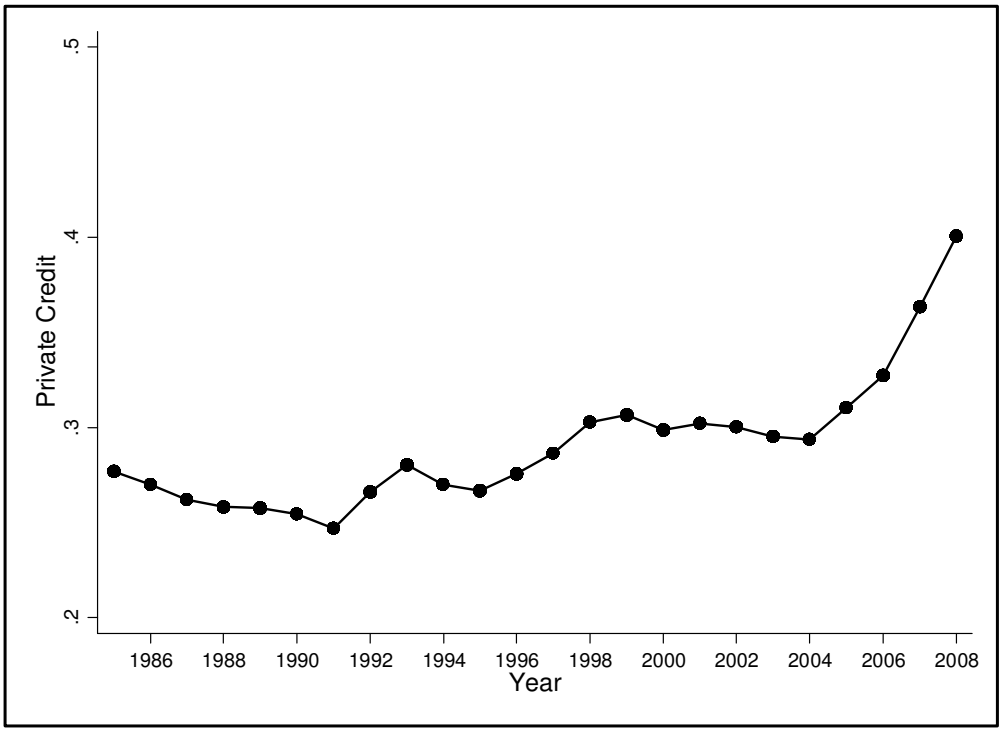


Figure 3.8: Plots of Commercial-Central Bank Assets over 1985-2008

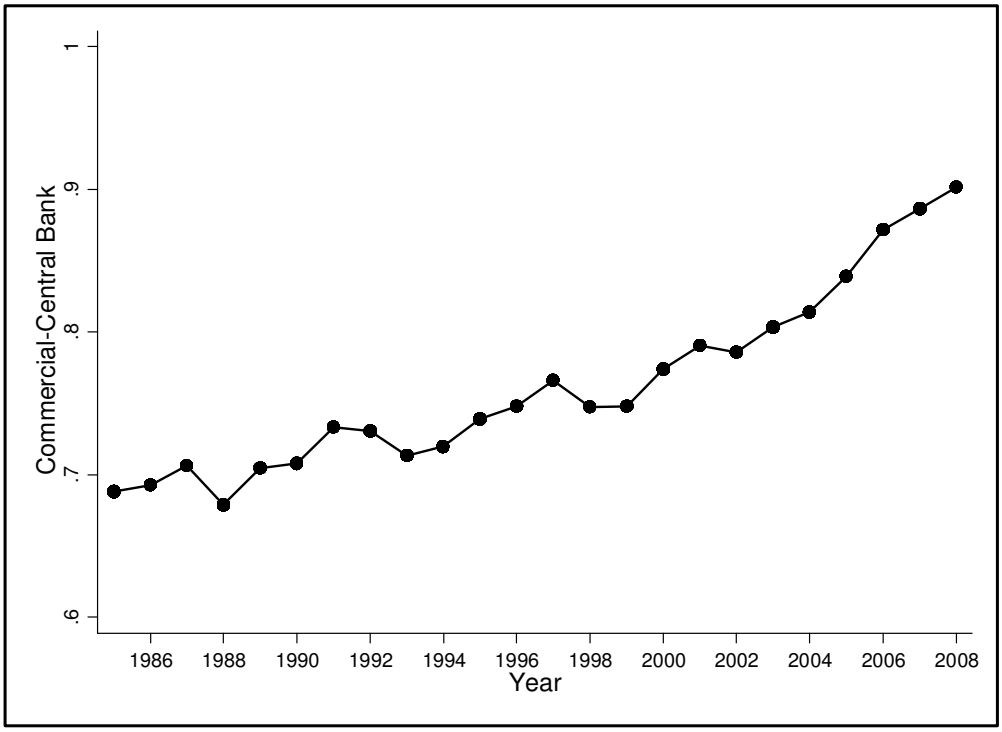


Figure 3.9: Plots of Turnover ratio over 1985-2008

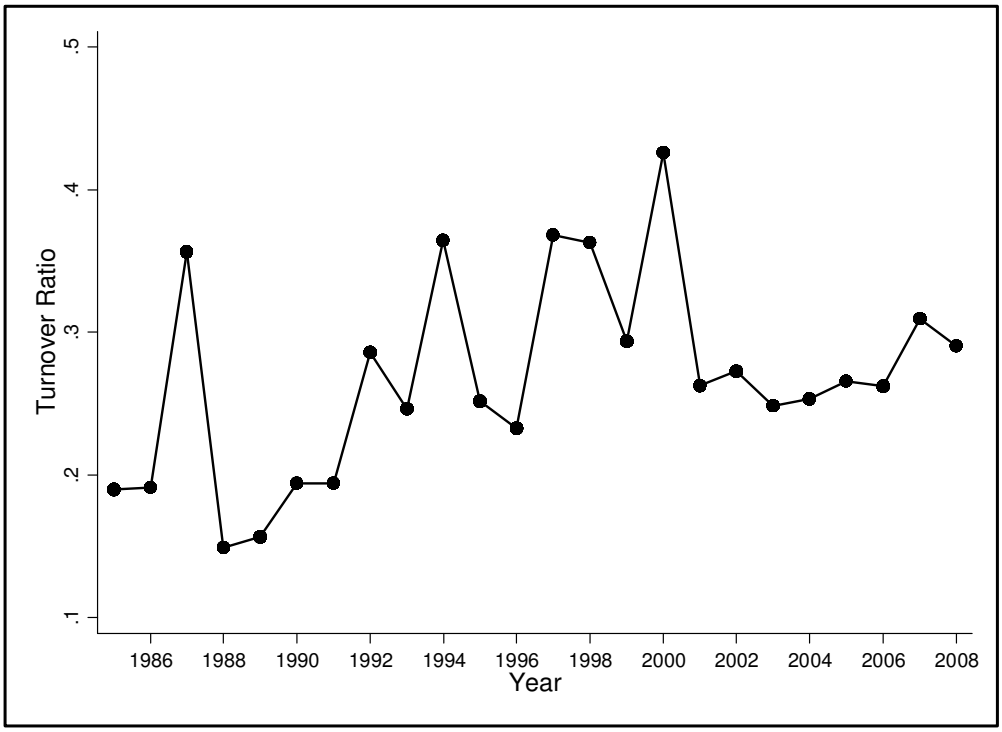
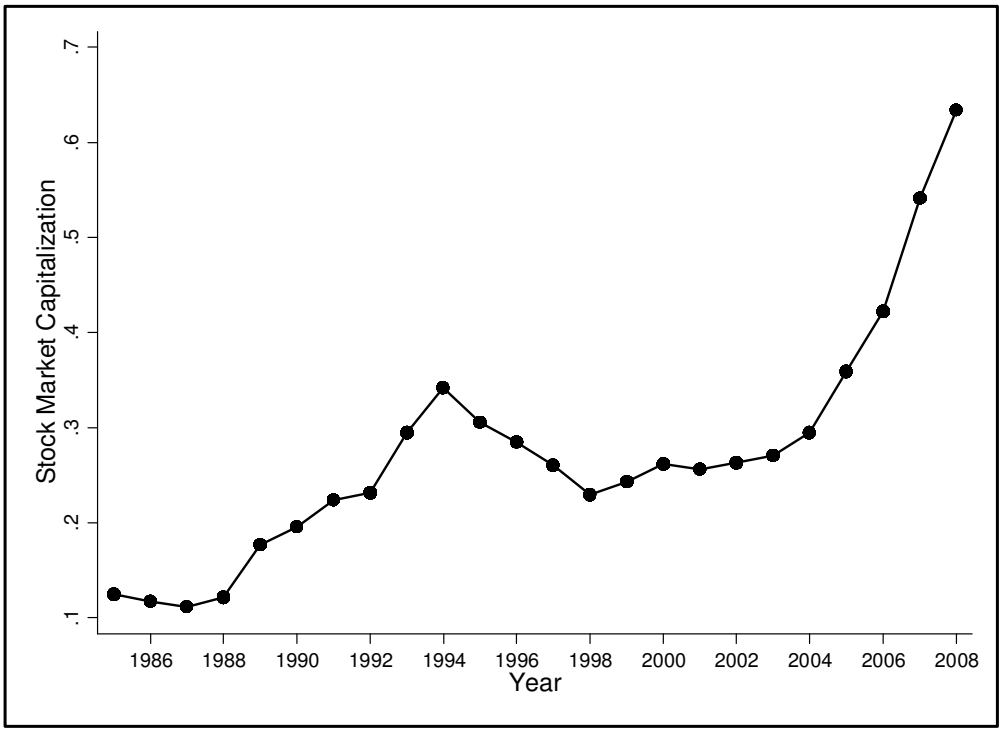


Figure 3.10: Plots of Stock Market Capitalization over 1985-2008



Chapter 4 : Determinants of CO_2 and SO_2 Emissions: Empirical Evidence for Different Political Regimes

4.1. Introduction

Scientific opinion is unanimous that environmental degradation is the direct consequence of human activities around the world. Many researchers have focused on examining the relationship between the quality of the environment and both economic and socio-demographic variables. Examples of these variables are the income level, economic growth, trade openness, technologies, urbanization, energy intensity, population size and density, and age structure (see, for example, Grossman and Krueger, 1995; Dietz and Rosa, 1997; Heil and Selden, 2001; York *et al.*, 2003; Cole and Neumayer, 2004; Fan *et al*,. 2006; Auci and Becchetti, 2006; Managi *et al.*, 2009; Naryan and Naryan, 2010). In analysing the effects of these variables on the environment, a large number of studies in the literature have considered measure for air quality, notably emissions of carbon dioxide (CO_2) and sulphur dioxide (SO_2).

Within this body of literature there are several studies which have assessed whether the political regime plays any role in shaping the economic performance of a particular country. On the empirical side, several studies have included a measure of democracy in their explanatory variables to assess the impact of political institutions on air pollution. Midlarsky (1998) and Shafik and Bandyopadhyay (1992) provide evidence of a positive impact of democracy on CO_2 and SO_2 emissions. On the other hand, a large number of empirical analysis have documented that more democratic countries are associated with lower levels of CO_2 and SO_2 emissions (Torras and Boyce, 1998; Scruggs, 1998; Barrett and Graddy, 2000; Farzin and Bond, 2006; Li and Reuveny, 2006; Bernaeur and Koubi, 2009; Menz and Kühling, 2011; Arvin and Lew, 2011). Overall, whereas the theoretical literature is ambiguous regarding the effect of political regime on pollution, the empirical research, with some exceptions, is generally in support of a beneficial effect of democracy on air quality.

All the afore-mentioned studies have implicitly assumed that the impact of the driving forces of pollution, such as rising population and increasing levels of production, are

homogenous across different political regimes. However, this assumption should be questioned: in practice, if democracies deliver better environmental outcomes than non-democracies, they should do so by successfully mitigating the adverse impacts of the driving forces of pollution. This in turn indicates that the relationship between, for example, production and emissions will be different in democracies as opposed to dictatorships. The only exception is Farzin and Bond (2006) who use interaction terms between a democracy index and a set of explanatory variables. However, because their focus is on the *degree* of democracy, their analysis does not allow us to assess differences in effects across different *kinds* of political regime.

This chapter is aimed at estimating the differential effects of the main factors underlying CO_2 and SO_2 emissions across democracies and dictatorships. Specifically, I carry out the empirical investigation in three steps. First, I quantify the impact of the level of income (proxied by per capita GDP), population size, the share of population aged less than 15, and trade openness, on CO_2 and SO_2 for a large sample of countries. These are commonly seen as the main driving forces underlying CO_2 and SO_2 emissions. This model can be considered as the baseline specification. Next, I proceed to explore the differences in the driving forces across different political regimes. To do so I use a set of the interaction terms between the explanatory variables and dummies for the kind of political regime. Finally, I re-estimate the differential impact across political regimes using a flexible functional form which allows the effects to vary with a country's stage of development. I do so by including the interactions between the explanatory variables (population, youth and openness) and the level of per capita GDP into the specification.

My work differs from existing empirical studies mainly in three key ways: (i) I relate the effects of the determinants of emissions to the kind of regime, namely democracy vis-à-vis dictatorships. This allows me to focus on the interaction effects between the political regimes and the driving forces under investigation; (ii) I use a more recent, comparable and consistent dataset on political regime which comes from Cheibub *et al.* (2010). This index is constructed based on well-defined classification rules and operational definitions and, thus, it is more reliable for empirical analysis than alternative indices of democracy; (iii) I estimate the empirical model in a dynamic framework using a two-step system GMM estimator, which allows us to obtain consistent estimators when the lagged dependent variable is included in the set of

controls. Further, this methodology is also effective in controlling for unobserved country-specific time-invariant effects.

The primary findings are follows. First, I find significant evidence supporting an inverted U-shaped relationship between income and emission levels, known as the environmental Kuznets curve, for the full sample of countries. My findings also suggest that population levels and openness have positive and significant effects on emissions. This holds for both CO_2 and SO_2 emissions. However, the share of youth seems to have no statistically significant impact on emissions levels. When the differential effects of the determinants of CO_2 and SO_2 emissions across democratic and non-democratic regimes is examined, I find that the estimates of the baseline model hold for both political regimes with the exception of the per capita GDP squared term on CO_2 emissions which turns statistically insignificant for dictatorships. When the effects of the underlying determinants of air pollution are interacted with the level of income, the results suggest that the adverse impacts weaken as a country achieves higher levels of income. However, several differences across political regimes emerge. Specifically, the estimates display that the adverse impact of increasing levels of population on air quality is generally less strong under dictatorships than under democracies. Conversely, the adverse impact of greater trade openness is stronger under dictatorships than under democracies. Finally, the impact of youth on SO_2 emissions turns out to be statistically significant for democracies only. Taken together, such findings suggest that empirical studies which simply include democracy in the set of explanatory variables are likely to yield an overly optimistic view of the effect of democracy on environmental quality.

The rest of the chapter is structured as follows. Section 2 illustrates both theoretical and empirical works explaining the potential impact of the key factors on CO_2 and SO_2. The empirical model along with the estimation method is presented in Section 3. Section 4 describes the data used in this study. Section 5 displays the empirical findings. Finally, Section 6 concludes the Chapter.

4.2. Literature Review

It is well established among scientists that increased emissions of CO_2 and SO_2 mainly result from anthropogenic factors.[1] Among the driving forces underlying air pollution, the main ones are: (i) levels of production (proxied by income levels); (ii) population size; (iii) age structure; (iv) openness toward international trade; (v) political regime. This section provides a review of the literature on the impact of such factors on air pollution.

4.2.1. Levels of income

A large body of the literature has focused on the impact of economic growth processes on the environment. The fundamental question is whether there is a trade-off between a process of sustained growth and environmental quality, or, on the contrary, whether economic growth is (or, at least, can be) part of the solution of environmental problems.

About 40 years ago, Meadows *et al*. (1972) argued that economic growth is one of the major threats to environment quality. From a policy prospective, they suggest a steady-state economy with zero growth in order to prevent the occurrence of ecological disasters in the future. However, these sort of pessimistic ideas about a trade-off between economic growth and environment quality have been criticised on several theoretical and empirical grounds. For example, Goodland and Ledec (1987) point out that "government concerned with long term sustainability need not seek limit growth in economic output so long as they stabilize aggregate natural resource consumption" (p. 39). Other researchers take even more optimistic views, considering economic growth as a solution to environmental problems (e.g., Bhagwati, 1993).

Empirical Studies

On the empirical side, several studies such as Shafik and Bandyopadhyay (1992), Panayotou, (1993) and Grossman and Krueger (1993) have provided evidence that

[1] It should be noted that global emissions of SO_2 emissions have decreased in the 1990s. However, the trend seems to have reversed afterward (see Smith *et al*. 2010).

while economic growth is detrimental to environment in the early stages of development, it leads to an improvement in the environment quality when a country has achieved a relatively high level of development. This inverted-U shaped relationship between the level of income and environment quality is known as the Environmental Kuznets Curve, hereafter EKC. As quoted in the World Bank's World Development Report 1992 (IBRD, 1992), according to the EKC advocates, "the view that grater economic activity hurts the environment is based on static assumptions about technology, tastes and environment investment" (p. 38).

More recent studies on the relationship between income and environmental quality have provided mixed results. For example, Cavlovic *et al.* (2000) run a meta-analysis of a number of studies to explore the income turning point concerning the EKC. They find that the magnitude of the turning point is sensitive to methodological choices. They also find that the income turning point is higher for CO_2 than for SO_2. Likewise, Harbaugh *et al*. (2002) examine the relationship between air pollution and GDP per capita using two different datasets on SO_2. They find that the empirical EKC is very sensitive to both the source of pollution data and econometric specifications.

Perman and Stern (2003) test the EKC hypothesis in a cointegration framework using data on a sample of 72 countries. They find no evidence of an inverted-U shaped relationship between per capita income and SO_2. Bertinelli and Strobl (2005) use a semi-parametric Kernel regressions method on CO_2 and SO_2 emissions data for 122 countries covering the period from 1950-1990. They show that the relationship between air pollution and GDP per capita is (positively) linear.

Galeotti *et al*. (2006) study how per capita GDP affects the level of emissions (CO_2) separately for OECD and non-OECD countries. They find evidence in favour of the EKC only for the OECD countries. In contrast, they show that the relationship between GDP and the level of emissions is less pronounced (relatively slow concaved EKC curve) for non-OECD countries.

Narayan and Narayan (2010) analyse the relationship between CO_2 emissions and income per capita for a panel of 43 developing countries in the years between 1980 and 2004. They find that the short-run income elasticity is bigger than the long-run elasticity

for about 35 percent of the countries included in the sample, providing some evidence for the existence of the EKC. In a recent paper, Hossain (2011) documents similar results for a panel of newly industrialized countries.

To summarize, the existing empirical findings are generally in support of a statistically significant relationship between the level of income and air pollution. Yet the argument that growth eventually turns beneficial for environment remains controversial. Even in a win-win scenario where growth and environmental quality goes together, economic growth in itself does not seem to be a satisfactory way to solve the problem of environmental degradation.[2]

4.2.2. Population

Several studies in the literature have provided evidence of a significant impact of demographic factors such as population size, urbanization and age structure on environment quality. The fundamental issue is whether rapid population growth would lead eventually to natural catastrophes, for example famine, due to increasing pressure on environmental resources.

Scientific analysis of the relationship between population and environment was pioneered by Thomas Maulthus (1798) in "*Essay on the Principle of Population"*. Malthus' popular view was that the growth of population would have outpaced food production which eventually results in a scarcity of natural resources. Debates in the 1960s on the impact of demographic factors on the environment have revived the Malthusian tradition. For example, Ehrlich's (1968) book "*Population Bomb"* warned of imminent worldwide episodes of famine as a consequence of the growing population. More recently, some scholars have pointed out that environment resources are not keeping pace with humankind needs (e.g., Daily and Ehrlich, 1992). On the other hand, some scholars have argued that it is likely that population pressure on environment resources would be counterbalanced by technological advances which improve humankind capabilities to cope with environmental issues (Boserup, 1981; Simon, 1981).

[2] When mentioning Arrow *et al*. (1996), Cavlovic *et al*. (2000) points out that the "EKC relationship should not be interpreted as a substitute for environmental policy or institutional change" (p. 32).

Along with the effect of the size of pollution on environment quality, considerations on the age composition of population have also been raised recently. The impact of population on pollution might be heterogeneous across different age cohorts since consumption, work and leisure habits, recreational activities, and sensibility toward environmental problems substantially vary with age (Tonn *et al*., 2001). For example, the share of the working age population might have a higher impact on air pollution as compared to the younger and older shares of population. In addition, a higher share of youth could strengthen the environmental preferences of the older share of population in the pursuit of leaving a better environment for their children (intergenerational environmental altruism).

Empirical Studies

On empirical grounds, there is ample evidence showing a significant relationship between population and air quality. For example, Dietz and Rosa (1997) estimate a cross-section regression for year 1989 to examine the impact of population on CO_2 emissions for a large panel of countries. They find that emission levels are a positive linear function of population size. This implies that population affects air quality adversely. Further their results suggest that the emission levels turn to be a quadratic function of population when China and India are included in the sample.

Shi (2003) uses a GLS estimation approach and examines the effect of size and age structure of population on CO_2 for a dataset of 93 countries over the period from 1975 to 1996. He finds that a higher percentage of working-age population leads to higher CO_2 emission levels. With regard to population size, he finds that the effects on emissions are conditional to per capita income levels. Specifically, the impact is (positively) stronger in countries with low income levels as compared to countries with high income levels.

York *et al*. (2003) run a cross country regression on CO_2 emissions for 146 countries for the year 1996. They show that the impact of the share of population aged 15-65 is positive but statistically insignificant. Cole and Neumayer (2004) analyse the impact of a number of demographic factors on both CO_2 and SO_2 emissions. They find that the relationship between population and air pollution is linear for CO_2 and U-shaped for

SO_2. Their findings provide no evidence of a statistical significant impact of age structure on emission levels.

Fan *et al*. (2006) analyse the effect of several variables including population and age composition on CO_2 emissions for a large panel set of countries over the period 1975-2000. Their findings suggest that the impact of population size and age composition varies at different income levels. Specifically, they show that the impact of population on emissions is stronger for the sample upper-middle income countries, and it is weaker for the lower middle income cohort. They also document a negative effect of population aged 15-64 on emissions at the high income level, while the effect turns positive for poorer countries.

Martínez-Zarzoso *et al*. (2007) analyse the impact of population growth on CO_2 emissions in European Union countries during the period 1975-1999. Their results indicate that the detrimental impact of population growth is higher for new members of the EU compared to the old EU members – the former being less rich than the latter, on average. Using SO_2 emissions data from Stern (2005), Menz and Kuhling (2011) estimate the impact of the share of young population on air pollution for a panel of 25 OECD countries. Their analysis covers the period from 1970-2000. They find a negative relationship between the share of the population under 15 years and emission levels. They also show that this negative effect weakens as income per capita increases.

Overall, the empirical analysis does provide evidence of significant effects of population on air pollution. However, the severity of this impact is likely to be heterogeneous across countries depending on the level of income. Furthermore, other demographic factors, particularly age structure, might also be significant in affecting air pollution.

4.2.3. International trade

Trade openness is another important determinant of air pollution. A large number of studies have shown that there is a significant relationship between international trade and both CO_2 and SO_2. In principle, it is possible that free trade might have both positive and negative effects on emissions levels.

Many scholars have pointed out that free trade activities lead some countries to exploit a comparative advantage in "dirty production". For example, according to the *pollution heaven hypothesis* (PHH henceforth) the trade of "dirty goods" leads pollution intensive industries to relocate in countries with low environmental standards, namely poor countries (e.g., Saint-Paul, 1994; Copeland and Taylor 1995).[3] However, according to the factor endowment hypothesis, dirty production is likely to move in countries with high capital to labour ratio, not necessarily to the poorer countries (e.g., Antweiler *et al*., 2001). Moreover, if countries relax their environmental regulation to avoid an outflow of capital, then free trade might trigger a *race to the bottom* (Daly, 1993). Another strand of the literature argues that trade is good for the environment because it encourages the diffusion of clean technology and extends environmental consciousness around the globe (Bhagwati, 1993).

Empirical Studies

Earlier empirical studies have found that trade is good for air quality. For example, Grossman and Krueger (1993) use the dataset collected by the Global Environmental Monitoring System (GEMS) to estimate the impact of trade policy on SO_2 emissions for a number of countries. Using total trade to GDP ratio as a proxy for trade openness, they show that countries with higher levels of trade have lower levels of emissions. Similar results are found by Shafik and Bandyopadhyay (1992), who focus on the impact of trade on SO_2 emissions for a panel of 149 countries spanning the years between 1960 and 1990.

Recent studies examine the conditional impact of trade openness on air quality, depending on the level of income. For example, Heil and Selden (2001) allow the impact of trade on carbon emissions to vary with the level of income by interacting trade intensity with per capita GDP. They use data for a panel of 132 countries between the period 1950 and 1992. They find that the effect of trade on air pollution is asymmetric across different level of income. Specifically, their results show that while

[3] It is interesting to note that if the PHH holds then the EKC scenario provides overly optimistic forecasts of emission trend in relatively poor countries. Specifically, once higher levels of income will be achieved, these countries will find no locations beyond their national borders where to transfer polluted activities. As a result the income turning point for these countries might be considerably higher as compared to the level found by current statistical estimates (see Kearsley and Riddel, 2010).

trade openness leads to higher emissions in poorer countries, it is likely to reduce the level of emissions in relatively richer countries.

Cole (2004) tests the PHH using several different measures of pollution for USA, Asia, UK, Latin America and Japan. His analysis covers the period from 1980 to 1997. Cole uses two variables, namely, the ratio of dirty exports to total exports in non-OECD countries and the ratio of dirty imports to total imports from the non-OCED countries. Their results provide evidence in favour of the PHH for 2 (SO_2 and biological oxygen demand) out of 10 pollutants.

Managi (2004), using the instrumental variable estimation method, examines the impact of trade on CO_2 emissions for a panel of 60 countries, covering the time span from 1960-1990. He finds that higher levels of trade lead to higher emission levels of CO_2. Moreover, his findings show that the adverse impact of trade on environment increases as the level of income increases.

Frankel and Rose (2005) quantify the effect of trade openness on air pollution for a panel of about 40 countries in 1990. They find evidence that trade has a significant negative effect on SO_2 emissions, while the impact on CO_2 is statistically insignificant. They also document that the negative relationship between trade and SO_2 emissions weakens as the level of income increases. This implies that the environmentally beneficial effect of trade is stronger for poor countries as compared to richer countries.

Managi *et al*. (2009) use a first difference GMM estimator to analyse the impact of trade on SO_2 and CO_2 emissions for a panel of 88 countries. The study covers the period from 1973 to 2000. They find that for OECD countries, trade openness has a statistically significant negative impact on the level of SO_2 and CO_2 emissions. However, they find evidence of adverse effects of trade on air quality for non-OECD countries.

Kearsley and Riddel (2010) study how trade affects CO_2 emissions for a panel of 27 OECD countries over the years between 1980 and 2004. Their findings provide no evidence of a statistically significant impact of trade on emissions. Similar evidence is documented by Sharma (2011), who examines the effect of trade on CO_2 separately for the samples of high, middle and low income countries.

To summarise, empirical evidence, with some exceptions, generally seems in support of a significant relationship between international trade and air pollution. However, there is no general consensus on whether the net effect is generally bad or good for the environment. Further, it seems that the impact of trade on air pollution is asymmetric across different levels of income.

4.2.4. Socio-Political regime

Since the characteristics of environmental quality, such as clean air and preservation of forest, are those of a public good, markets are unable to provide the optimal level of them. Some kind of state intervention is therefore necessary to overcome market failures. A large body of the literature has analysed whether countries with democratic institutions are more concerned with environmental issues as compared to non-democratic countries.

Because of electoral accountability, one would expect that democracies tend to meet higher environmental standards than dictatorships (Payne, 1995; Li and Reuveny, 2006). On the other hand, the literature also provides some theoretical arguments in favour of dictatorships. One line of reasoning is based on the relative size of the national income share accruing to the actors who have a pivotal role in matter of the political process, namely the ruling elite in a dictatorship and the median voter in a democracy. It is likely that the share of national income held by the ruling elite is substantially bigger than the share detained by the median voter. To the extent that environment is a normal good, dictatorships might well show more concerns toward environmental issues as compared to democracies (Congleton, 1992).

Another argument in favour of dictatorships derives from a critique of electoral accountability as a mechanism that provides the stimulus to preservation of the environment (Bernaeur and Koubi, 2009). While the benefits from stricter environmental policies on air pollution manifest in the long run, the costs associated with them materialize in the short term. This means that a myopic voter will not reward a pro-environment policy maker. On the other hand, if the ruling elite has a strong hold on power, an authoritarian regime might be in a better position to implement environmental policy precisely because, unlike democracies, the dictator face no

elections.[4] In a similar vein others scholars, such as Hardin (1968) and Heilbronner (1974), suggest that democracies dare not impose "harsh" measures that counteract the individual's inclination to over exploit public resources. In this view, only dictatorships are capable of doing so.

Empirical Studies

Looking at the empirical evidence, we find that most of the prior studies, such as Torras and Boyce (1998), Scruggs (1998), Barrett and Graddy (2000), Gleditsch and Sverdrup (2003), Bernaeur and Koubi (2009) and Arvin and Lew (2011), have documented that democracy is good for environment quality. However, a few studies, such as Midlarsky (1998) and Shafik and Bandyopadhyay (1992) provide evidence of a detrimental impact of democracy in terms of relatively high CO_2 and SO_2 emission levels. Midlarsky (1998) run a cross-section analysis on CO_2 emissions for a sample of 98 countries for the year 1990. He finds that more democratic countries are associated with higher levels of CO_2 emissions. Similar results are found by Shafik and Bandyopadhyay (1992) for SO_2 emissions.

Barrett and Graddy (2000) estimates the effects of the level of democracy on SO_2 emissions for a pooled sample of countries over a period of 33 years. As a measure of democracy they use the Freedom House indexes of political and civil freedoms which rank countries on a scale from 1 to 7, where 7 is the lowest level of freedom. Their findings suggest that higher levels of democracy lead to lower SO_2 emissions.

Gleditsch and Sverdrup (2003) examine the impact of political regimes on per capita CO_2 emissions for a sample of 108 countries in 1990. They use a categorical variable for political regime based on a dichotomization of the Polity index of democracy. Their analysis suggests that democratic countries have lower CO_2 emissions than non-democratic countries.

Farzin and Bond (2006) use a fixed effects model for a panel of countries to study the effect of the degree of democracy on air pollution. They use both CO_2 and SO_2

[4] It has to been noted that this argument in favour of dictatorships assumes that environment figures into the dictator's objective function.

emissions as a measure of air pollution in their analysis. Their set of explanatory variables includes interaction terms with per capita GDP as well as the degree of democracy. They show that at low levels of income, an increase in the level of democracy leads to higher CO_2 and SO_2 emissions. However, this effect weakens and even turns negative as income rises. Similarly, Li and Reuveny (2006) focusing on a panel of 143 countries from 1961 to 1997 show that more democratic countries produce lower CO_2 emissions per capita.

Bernaeur and Koubi (2009) quantify the impact of democracy on SO_2 concentrations for a panel of 42 countries over a time period between 1971 and 1996. They employ both fixed and random effects methods to estimate their empirical models. They use Bueno de Mesquita *et al.*'s (2003) measure of democracy as well as the civil liberties index constructed by the Freedom House as a proxy for interest groups' power. They find that higher degree of democracy is good for the environment. In contrast, the coefficient of civil liberties is positive, but it appears to be statistically insignificant.

Recently, Arvin and Lew (2011) study whether the effect of democracy on CO_2 differs across different levels of income as well as across different geographical regions. They use a panel of 141 countries between 1976 and 2003. They find that the effect of democracy on pollution is negative and statistically significant for the sample of middle-income economies while the impact turns statistically insignificant for the samples of high and low income countries.

4.3. The Model

On the theoretical side, the impact of democratic institutions on the environment is ambiguous, yet the large majority of previous studies find that democracies perform better than dictatorships, at least for CO_2 and SO_2 emissions: countries with higher levels of democracy are shown to emit lower levels of emissions.

All the afore-mentioned studies are based on a reduced-form model which examines the direct effect of democracy on an environmental outcome. One problem with this approach is that pollution is closely related with a plethora of factors including

population, the level of production and technological progress. Simply including these factors in the set of control variables might not be a satisfactory approach to assess the role played by the political regime in environmental issues. I believe that democracies affect environmental outcomes, if at all, *indirectly*, by promoting legislation and environmental-friendly behaviour which effectively mitigate (strengthen) the adverse (beneficial) impacts of the driving forces underlying environmental degradation (protection).

For this reason, the hypothesis of homogeneity of the environmental impact of the driving forces across political regimes, which is implicit in previous studies, should be questioned. Indeed, the role played by democracy might be better assessed precisely by looking at differential effect in the relationship between the driving forces and environmental quality across democracies and dictatorships. One partial exception is Farzin and Bond (2006), who has studied the interaction terms between the policy variable and a set of other explanatory variables. I differ from their study mainly in two ways. First, rather than focusing on the *degree* of democracy, I use a dichotomous index of political regime which allows us to assess difference in effects across different *kinds* of political regime. Using a minimalist definition of democracy allows us to avoid the conceptual and methodological problems associated with the operationalization of the degree of democracy. Second, unlike Farzin and Bond (2006), I allow the emission levels to depend on their values in previous period to account for inertial effect. To do so I employ a technique precisely designed for dealing with dynamic models, namely system GMM estimator.

The empirical model along with the estimation technique used in the current study is displayed in this section. Data on political regime are illustrated in the next section.

4.3.1. The Empirical Model

Following prior studies that examine the determinants of air pollution, I start the empirical investigation by estimating the following model for the full sample of countries.

$$E_{i,t} = \alpha + \gamma_0 E_{i,t-1} + \gamma_1 GDP_{i,t} + \gamma_2 GDP_{i,t}^2 + \gamma_3 Pop_{i,t} + \gamma_4 Youth_{i,t} + \gamma_5 Open_{i,t} + \delta T + \psi_i + \varepsilon_{i,t} \quad (1)$$

where subscript i represents country and t represents time period. $E_{i,t}$ is the emission levels of the air pollutant. I consider two measures of air pollution, namely CO_2 and SO_2. The fundamental difference between these two measures of air quality is that the adverse effects of CO_2 are global in nature while SO_2 is primarily a local externality (Farzin and Bond, 2006, and the reference cited therein). $GDP_{i,t}$ is the level of per capita income of country i at time t. $Pop_{i,t}$ denotes the size of population, $Youth_{i,t}$ is the share of population under age of 15 and $Open_{i,t}$ is the ratio of total trade (exports plus imports) to GDP as a proxy for openness.[5] In keeping with previous studies, the exogenous component of technological progress is proxied by a linear time trend variable T (e.g. Bernaeur and Koubi, 2009; Farzin and Bond, 2006). The lagged-dependent variable is included in the right-hand side of the regression to account for inertia of environmental degradation (Li and Reuveny, 2006; Managi *et al*., 2009). ψ_i is a vector of country-specific time-invariant factors and $\varepsilon_{i,t}$ represents the disturbance process.

The selection of the explanatory variables is based on previous theoretical and empirical works (please see the literature review, section 4.2). There are other important factors, such as urbanization, the average household size and energy intensity which underlie emissions (e.g. Sharma, 2011; Poumanyvong and Kaneko, 2010; Cole and Neumayer, 2004). However, these factors are strongly correlated with the variables which have been included in Equation (1), particularly income levels (Menz and Kühling, 2011; Liddle and Lung, 2010; Zhao and Zhang, 2009). Thus, I am confident that the set of explanatory variables is picking up the main forces which affect the anthropogenic emissions of CO_2 and SO_2.

[5] There are other measures, such as the Dollar index and the parallel market exchange rate, to proxy for trade openness (see, for example, Shafik and Bandyopadhyay, 1992). I chose the share of trade in terms of GDP because its coverage of country is wider than alternative indices of openness. Sharma (2011), Kearsley and Riddel (2010) and Managi *et al*. (2009), among others, have used this index to assess the impact of openness on emissions.

All variables are measured in natural logarithms in keeping with the STIRPAT empirical literature.[6] This model can be viewed as the baseline specification. Whether a particular factor is good or bad for the environment depends on the sign and the statistical significance of the associated coefficient. A positive sign means that the factor under analysis exacerbates environmental degradation. Conversely, a negative sign means that the factor improves environmental quality. Since all the variables are in logarithm form the coefficients are empirical estimates of the elasticities of emissions with the exception of the income level. For instance, γ_3 is a measure of the responsiveness of emission levels to a change in population size. With regard to per capita GDP, an inverted U-shaped relationship between income and air pollution (the EKC) arises if $\gamma_1 > 0$ and $\gamma_2 < 0$ and both are statistically significant. The inclusion of the quadratic term complicates the interpretation of the income elasticity. The income elasticity of emissions indeed varies depending on the level of GDP.

4.3.2. The Differential Effects of the Determinants of Air Pollution across Political Regimes

To account for differential effects across political regimes, I generate the following two dummies: $PR_{i,t}^{D}$, which is equal to one if the country i is classified as democratic in year t and zero otherwise; and $PR_{i,t}^{N}$, which is equal to one if the country i is classified as dictatorship in year t and zero otherwise. Therefore, by construction, $PR_{i,t}^{D} + PR_{i,t}^{N} = \underline{1}$, where $\underline{1}$ is a vector of all ones. I then interact these two dummies with the explanatory variables. Specifically, I estimate the following model:

$$E_{i,t} = \alpha + \gamma_0 E_{i,t-1} + \left(\alpha_1 GDP_{i,t} + \alpha_2 GDP_{i,t}^2 + \alpha_3 Pop_{i,t} + \alpha_4 Youth_{i,t} + \alpha_5 Open_{i,t}\right) PR_{i,t}^{D} + \left(\beta_1 GDP_{i,t} + \beta_2 GDP_{i,t}^2 + \beta_3 Pop_{i,t} + \beta_4 Youth_{i,t} + \beta_5 Open_{i,t}\right) PR_{i,t}^{N} + \delta T + \psi_i + \varepsilon_{i,t} \quad (2)$$

Equation (2) allows us to capture differential effects of the underlying determinants of emissions across political regimes; if α_j is different from the corresponding coefficient

[6] The STIRPAT model is the stochastic generalization of the IPAT identity (Impacts by Regression on Population, Affluence, and Technology) which emphasizes the environmental impact of three factors, namely population, affluence (production) and technology. See York *et al*. (2003) for more details on the IPAT model and empirical application.

β_j in terms of sign and/or statistical significance, then there is evidence of a differential effect. Specifically, one could infer that democracy provides more environmental protection (or less environmental pollution) as compared to its autocratic counterpart if estimation of Equation (2) yields one of the two following outcomes:

i) α_j is negative and statistically significant for democracies while β_j is statistically insignificant or, if it is significant, has a positive sign.

ii) α_j is statistically insignificant for democracies whereas β_j is positive and statistically significant for dictatorships.

On the other hand, an outcome such as $\alpha_j > 0$ and $\beta_j < 0$ (both statistically significant), would indicate that dictatorships are more environmentally friendly than democracies. Still other scenarios, such as α_j and β_j both statistically significant with the same sign, would tell us that political regime play no relevant role in shaping the environmental impact of the driving force under study.

4.3.3. The Differential Effects of the Determinants of Air Pollution across Different Levels of Income and Different Political Regimes

Estimation of Equations (1) and (2) assumes that the effects of the underlying determinants of air pollution are homogenous across different income levels. However, as documented in the literature review, a number of empirical studies, such as Heil and Selden (2001), Shi (2003), Fan *et al*. (2006), Farzin and Bond (2006), Martínez-Zarzoso *et al*. (2007), Managi *et al*. (2009), and Menz and Kühling (2011), have documented that the impact of socio-economic factors varies at different levels of income. Thus, to account for such differential effect across different income levels, I augment Equation (2) by interacting the explanatory variables (population size, youth and openness) with the level of per capita GDP. Specifically, the model takes the following form:

$$E_{i,t} = \alpha + \gamma_0 E_{i,t-1} + \left(\alpha_1 GDP_{i,t} + \alpha_2 GDP_{i,t}^2 + \alpha_3 Pop_{i,t} + \alpha_4 Youth_{i,t} + \alpha_5 Open_{i,t}\right) PR_{i,t}^D + \left(\beta_1 GDP_{i,t} + \beta_2 GDP_{i,t}^2 + \beta_3 Pop_{i,t} + \beta_4 Youth_{i,t} + \beta_5 Open_{i,t}\right) PR_{i,t}^N + \left(\alpha_6 Pop_{i,t} + \alpha_7 Youth_{i,t} + \alpha_8 Open_{i,t}\right) PR_{i,t}^D \cdot GDP_{i,t} + \left(\beta_6 Pop_{i,t} + \beta_7 Youth_{i,t} + \beta_8 Open_{i,t}\right) PR_{i,t}^N GDP_{i,t} + \delta T + \psi_i + \varepsilon_{i,t} \quad (3)$$

Whether the impact of the specific factor on emission levels weakens or strengthens as income increases depends on the sign and the statistical significance of the interaction term between the variable and per capita GDP. For example, if both α_4 (β_4) and α_7 (β_7) estimates have the same sign and appear statistically significant then the predicted effects of youth on emissions levels would be larger at higher levels of income in democracies (dictatorships). On the other hand, if both estimates enter into the model with opposite (regardless of positive or negative) signs then a rise in income level would reduce the total effect of youth on emissions. The model given in Equation (3) not only allows for the differential effects of the explanatory variables across political regimes but it also enables us to examine whether these differential effects are conditional on income levels.

4.3.4. Estimation Method

In the literature, researchers have applied different estimators to quantify the effect of explanatory variables on air pollution. For instance, some studies, such as Torras and Boyce (1998), Li and Reuveny (2006) and Bernaur and Koubi (2009) have used OLS, Fixed effect and Random effect while others, such as Taskin and Zaim (2000) and Bertinelli and Strobl (2005), have utilized semi- or non-parametric methods.

Given the dynamic context of the empirical model, I use a two-step system GMM estimator developed by Blundell and Bond (1998). The OLS estimation of Equation (1) yields inconsistent estimates because of the presence of unobserved and time-invariant country-specific factors, ψ_i.To overcome the omitted variable problem, the common approach is to apply the within estimators. Specifically, such technique applies OLS estimation on demeaned data. Although the within estimator is effective in removing the unobserved fixed effects, these estimators yield a downward biased estimate of the coefficient of the lagged dependent variable (Nickell, 1981). Further, the coefficients of

other explanatory variables might also be biased if these are correlated with the lagged dependent variable (Baum, 2006).

The differenced estimator proposed by Arellano and Bond (1991) is a solution to this problem. Specifically, this estimator is robust to the bias introduced by the lagged dependent variable. Further, it also controls for potential endogeneity in the independent variables by using their lagged values as instruments in the estimation. More specifically, in Arellano and Bond fashion, the Equation (1) can be rewritten as follows:

$$\Delta E_{i,t} = \tilde{\gamma}_0 \Delta E_{i,t-1} + \tilde{\gamma}_1 \Delta GDP_{i,t} + \tilde{\gamma}_2 \Delta GDP_{i,t}^2 + \tilde{\gamma}_3 \Delta Pop_{i,t} + \tilde{\gamma}_4 \Delta Youth_{i,t} + \tilde{\gamma}_5 \Delta Open_{i,t} + \Delta \tilde{\varepsilon}_{i,t} \quad (4)$$

In Equation (4) all the variables are now expressed as first differences. The first differenced GMM estimator uses lagged levels dated $t-2$ and earlier as instruments.

It is important to note that the Arellano and Bond estimator suffers from a "weak" instruments problem when the dependent variable is highly persistent over time (Blundell and Bond, 1998). Arellano and Bover (1995) provide a solution for this problem by elaborating a system GMM estimator later fully developed by Blundell and Bond (1998). Specifically, the system GMM estimator runs simultaneously both an equation in levels (Equation 1) and an equation in first differences (Equation 4). This technique effectively overcomes the problem of weak instruments by using the additional moment conditions for the levels equation.

The consistency of the system GMM estimation depends on the absence of the autocorrelation in the residuals. I test this by applying the Arellano and Bond (1991) AR(2) test. Given the nature of the model, it is very likely that the residuals exhibit first order correlation. However, the first-differenced residuals are expected not to display second-order serial correlation. An additional assumption that has to be satisfied for the GMM estimator to be consistent is that the instruments are appropriately uncorrelated with the disturbance process. This is tested by using the *J* test for overidentifying restrictions developed by Hansen (1982).

4.4. Data and Variable Definitions

In this section I describe the sample and discuss data sources. I also provide definitions of the dependent variables and give some explanations of the index used for classifying political regimes. Definitions of the remaining variables in the analysis and data sources are given in Table C.1 in Appendix.

4.4.1. The Sample

This study is based on a fairly large unbalanced panel of both democratic and non-democratic countries. The size of panel varies according to the dependent variables, namely CO_2 and SO_2 emissions. Specifically, I construct the dataset for a total of 138 countries for the years between 1961 and 2007 for CO_2 emissions. For SO_2 emissions, the sample consists of 116 countries over the time period from 1961 to 2005. The samples have been selected to include only countries that have no missing data on the variables used in the analysis.

Approximately 46.7 (50) per cent of the country-year observations are classified as democratic in the CO_2 sample (SO_2 sample). Of the 138 (116) countries included in the CO_2 (SO_2) sample, 51 (41) have experienced at least one regime transitions over the examined period. The list of sample countries is given in Table C.2 in Appendix.

4.4.2. CO_2 Emissions

I use the log of CO_2 emissions as a measure of air pollution.[7] Data on CO_2 emissions are obtained from World Development Indicators database developed by the World Bank. Specifically, the data on CO_2 emissions is collected by the Carbon Dioxide Information Analysis Centre, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, the United States. This data is made available by the World Bank.

Emissions of CO_2 are one of the main components of greenhouse gases which result in global warming and change in the overall climate. The main source of the emission of

[7] The extent of the emissions of CO_2 in air is measured in Kilotons.

carbon dioxide is the combustion of fossil fuels. The emissions of CO_2 have risen by approximately 1.9% per year during the last three decades. The estimated figures for 2030 are between 40% and 110% higher than emission levels in 2000 (IPCC, 2007).

4.4.3. SO_2 Emissions

I also use another measure of air pollution, namely sulphur dioxide (SO_2). Specifically, I use the natural logarithm of SO_2 emissions.[8] Unlike CO_2 emissions, SO_2 is a local pollutant. The combustion of coal and petroleum is the main source of SO_2 emissions. SO_2 considerably contributes to smog and localized air pollution and acid rain. Emissions levels of SO_2 declined since the mid of the 1970s until 2000 with a reversal in the trend afterward (Smith *et al*., 2010).

The data are obtained by Smith *et al*. (2010) who provide estimates of global and country-level sulphur dioxide anthropogenic emissions for the period 1850-2005. The emissions have been constructed using calibrated country-level inventories data compiled from a large variety of sources.[9]

4.4.4. Political Regime

To examine the differential effect of the driving forces underlying CO_2 and SO_2 emissions across different political regimes, I use the index of democracy constructed by Alvarez *et al*. (1996) and later extended by Cheibub *et al*. (2010) in terms of both time and coverage of countries. This index is a binary variable which takes value one if the country is classified as democratic and zero if the country is classified as non-democratic. The criteria underling regime classification has already been illustrated in Chapter One. This subsection explains further why I prefer this index to alternative operationalizations of political regime.

[8] SO_2 emissions are measured in gigagram (Gg).
[9] See Smith *et al*. (2010) for more details on the construction of the dataset.

One common critique to the measure from Cheibub *et al.* is that the coding rules are based on a minimalist definition of democracy and, as such, they are incomplete. [10] For example, it can be argued that the presence of contested election is not enough to call a regime as democratic. In addition, categorical indices cannot accounts for cases of countries being more democratic than others. For these reasons, some researchers advocate the use of continuous indices, such as the Freedom House and the Policy Index, based on maximalist definitions of democracy. According to these indices, regimes differ with each other in the "degree" of democracy. However, maximalist definitions of democracy and continuous indices entail even more serious problems than minimalist indices. The fact that some countries are more democratic than other by no means implies that democracy is an intrinsic attribute of all regimes. To argue that all countries have some positive degrees of democracy or, saying that a country is less democratic than another, seems to make not much sense in cases such as China in the 1970s, Pinochet's Chile and the military's Brazil. After all, although the presence of contested elections is not sufficient, it is nonetheless a necessary condition to give a political regime any feature of democracy.

In addition, maximalist definition of democracy blunders the boundary line between political regime and a desirable output. For example, when defining democracy as a regime where the ruler is held accountable by the electorate, rather than testing, one is *assuming* that a regime based on the majority rule works in line with the public interest. Moreover, the coding and aggregation rules to construct continuous indices are often unclear and embody a high degree of subjective judgement (e.g. Arndt and Oman, 2006). Obtaining all the pieces of information required for their construction is such a hard task that the coding of democracy sometime seems to be based on guesses (Cheibub *et al.*, 2010). In contrast, the coding rules underlying the Cheibub *et al.*'s index are transparent and the information they require is relatively easy to obtain. Although there might be cases which are not easy to be classified as democratic or not, the classification, once done, is unambiguous (either democracy or dictatorship).[11] If the

[10] All the conceptual and methodological issues discussed in the current context have been taken from Cheibub *et al.* (2010). For a painstaking illustration of these and other problems underlying alternative indices of democracy, the reader could also consult Munck and Verkuilen (2002) and Arndt and Oman (2006).

[11] Li and Reuveny (2006) have used a discrete cut-off from the Polity index to categorize political regimes in democracy and dictatorships. I still prefer Cheibub *et al.*'s index because there are no theoretical reason to select any specific threshold on a scale of -10 to 10.

researcher does not agree with the classification of some countries, she still can reclassify these cases according to her view (dictatorship instead of democracy and vice versa).

To conclude, although a minimalist index of democracy has several limitations, I believe, in line with Cheibub *et al.* (2010), that for practical purposes, continuous indices of democracy do not offer a valid alternative. For this reason, I prefer to focus on the *kind* of political regime rather than the *degree* of democracy.

4.5. Empirical Findings

4.5.1. Summary Statistics and Correlation Estimates

Table 4.1 presents summary statistics for the full sample, as well as for both democracies and non-democracies, based on CO_2 data availability. Specifically, the table reports means, standard deviations (in parenthesis) and a *t*-test on the equality of means across democracies and dictatorships.

Table 4.1: Summary Statistics - CO_2

Variables	Full Sample	Democracy	Dictatorship	*t*-test (*p*-value)
CO_2	9.301	10.161	8.547	0.000
	(2.411)	(2.115)	(2.402)	
GDP	8.366	9.038	7.777	0.000
	(1.283)	(1.090)	(1.142)	
Pop	15.869	15.964	15.786	0.000
	(1.664)	(1.698)	(1.630)	
Youth	3.512	3.321	3.679	0.000
	(0.332)	(0.341)	(0.212)	
Open	3.994	3.996	3.992	0.853
	(0.716)	(0.670)	(0.754)	

Notes: The table illustrates the means of the variables used in the analysis (standard deviation in parentheses). The last column reports the *p*-values from the *t*-tests on the equality of means across democracies and dictatorships.

The mean value of CO_2 for the full sample is 9.30. On average, the level of CO_2 emissions is smaller in non-democracies as compared to their democratic counterparts. The average income (log of per capita GDP) for the democracy sample is 9.04, while the corresponding figure for the non-democratic sample is 7.78. This implies that

countries with a democratic political system have on average higher income levels as compared to non-democratic countries over the examined period. Average population is slightly higher in the sample of democratic countries as compared to the sample of non-democratic countries. Regarding youth, the table indicates that the share of young population on average is higher in non-democratic countries than in democratic countries. However, there is no significant difference in the average of the trade openness measure across political regimes.

Table 4.2 presents summary statistics for the sample based on the availability of SO_2 data. The average value of SO_2 is 4.85 for the full sample of countries. The differences in variables across political regimes are similar to the case of CO_2. The only exception is population, for which the difference in the means across democracies and non-democracies is now statistically insignificant.

Table 4.2: Summary Statistics - SO_2

Variables	Full Sample	Democracy	Dictatorship	*t*-test (*p*-value)
SO_2	4.850	5.249	4.453	0.000
	(2.022)	(1.903)	(2.058)	
GDP	8.561	9.138	7.986	0.000
	(1.202)	(0.991)	(1.116)	
Pop	16.122	16.121	16.124	0.942
	(1.572)	(1.629)	(1.513)	
Youth	3.482	3.304	3.661	0.000
	(0.333)	(0.330)	(0.221)	
Open	3.931	3.922	3.941	0.399
	(0.726)	(0.674)	(0.774)	

Notes: The table illustrates the means of the variables used in the analysis (standard deviation in parentheses). The last column reports the *p*-values from the *t*-tests on the equality of means across democracies and dictatorships.

To have some preliminary evidence on the interactions between the measures of air quality and other explanatory variables, I estimate simple correlations. Tables 4.3 and 4.4 present the estimates of correlation for CO_2 and SO_2, respectively.

In both tables, column 1 reports correlations for the full sample of countries, while columns 2 and 3 report the correlations estimates for democratic and non-democratic samples, respectively. The estimates reveal that both the level of income and the size of

population are positively correlated with emission levels, while the correlation between emission levels, youth and openness is negative. From these figures it seems that both income and population levels have an adverse impact on air quality. Conversely, the environmental impact of youth and openness appears to be beneficial. These estimates of correlation hold for both the full sample as well as the samples of democracies and non-democracies, though the magnitude of coefficients differs across political regimes, particularly for openness.

Table 4.3: Correlation Matrix - CO_2

Variables	Full Sample	Democracy	Dictatorship
GDP	0.587	0.487	0.538
	(0.000)	(0.000)	(0.000)
Pop	0.684	0.761	0.670
	(0.000)	(0.000)	(0.000)
Youth	-0.561	-0.494	-0.511
	(0.000)	(0.000)	(0.000)
Open	-0.228	-0.476	-0.083
	(0.000)	(0.000)	(0.000)

Notes: The table shows simple correlations between CO_2 emissions and explanatory variables (*p*-values in parentheses).

Table 4.4: Correlation Matrix - SO_2

Variables	Full Sample	Democracy	Dictatorship
GDP	0.345	0.272	0.308
	(0.000)	(0.000)	(0.000)
Pop	0.672	0.733	0.642
	(0.000)	(0.000)	(0.000)
Youth	-0.390	-0.295	-0.434
	(0.000)	(0.000)	(0.000)
Open	-0.362	-0.554	-0.217
	(0.000)	(0.000)	(0.000)

Notes: The table shows simple correlations between SO_2 emissions and explanatory variables (*p*-values in parentheses).

4.5.2. Estimation Results

Benchmark Model

The empirical findings from the baseline model, as shown in Equation (1), are given in Panel A of Table 4.5. Models 1 and 2 display the empirical estimates of the driving

forces of CO_2 and SO_2 emissions, respectively. Panel B of the table reports diagnostic tests. The AR(2) test rules out second-order serial correlation of the residual terms. Further, the Hansen test does not reject the null hypothesis of no correlation between the instruments and the residuals. Therefore, I am confident that the GMM estimator is yielding consistent estimates.

The estimated coefficient of per capita GDP is positive and statistically significant, while the estimate of the square of per capita GDP is negative and statistically significant for CO_2. These findings are in line with the literature on the EKC and suggest that there is an inverted U-shaped relationship between the level of income and emission levels.

Table 4.5: System GMM Estimates on the Determinants of CO_2 and SO_2 - Full Sample

Panel A: Estimation Results		
	Model 1 (CO_2)	**Model 2 (SO_2)**
$GDP_{i,t}$	0.318*** (0.101)	0.324*** (0.117)
$GDP_{i,t}^2$	-0.015*** (0.005)	-0.018*** (0.007)
$Pop_{i,t}$	0.081*** (0.018)	0.029** (0.014)
$Youth_{i,t}$	0.025 (0.027)	0.056 (0.035)
$Open_{i,t}$	0.096*** (0.023)	0.051** (0.023)
$E_{i,t-1}$	0.944*** (0.015)	0.983*** (0.012)
Trend	-0.003*** (0.001)	-0.002*** (0.001)
Constant	-2.696*** (0.586)	-2.071*** (0.599)
Panel B: Diagnostic Tests		
AR(2)	0.448	0.932
Hansen test	0.141	0.128
Observations	5222	4047
Countries	138	116
Instruments	35	53

Notes: The table shows the main determinants of emission levels. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Model 1 estimates the determinants of CO_2. Model 2 estimates the determinants of SO_2. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

As expected, the results from Model 1 indicate that the level of emissions is positively and statistically significantly related to the size of population. This suggests that the higher the level of population, the higher the level of emissions. This result is consistent

with the findings of Dietz and Rosa (1997), Shi (2003) and Fan *et al*. (2006), who also document a positive relationship between emission levels and population size. The coefficient associated with population, approximately 0.08, is well below 1. This finding strongly rejects the hypothesis of unitary elasticity of population which is implicit in regressions where the dependent variable is emissions *per capita*.

The results given in Table 4.5 also provide evidence of a significant relationship between CO_2 emissions and trade openness. Specifically, the estimated coefficient of trade openness is positive and statistically significant, suggesting that rising levels of international trade have adverse effects on air quality. This result agree with the empirical works of Heil and Selden (2001), Managi (2004) and Cole and Elliott (2004), who also find a positive impact of trade openness on CO_2 emissions levels. I also find that the share of population aged below 15 is positively associated with CO_2 emissions. One possible explanation is that youth have relative high propensity of consumption in energy intensive sectors. However, the coefficient fails to achieve the standard levels of significance. This finding is in line with York *et al*. (2003) and Cole and Neumayer (2004) who show that age structure affects neither the level of CO_2 nor SO_2 emissions.

The results also indicate that there is high persistence in emission levels as the coefficient of one-period lagged emissions is positive and statistically significant.[12] These results agree with Li and Reuveny (2006) and Managi *et al*. (2009) who also find evidence of inertia in emissions. In line with empirical works such as Grossman and Krueger (1993) and Farzin and Bond (2006), the results show that the coefficient of time trend is negative and statistically significant. Such a downward trend might reflect rising environmental awareness and technological progress which has been made to curb emissions on a worldwide scale.

Turning to SO_2 emissions, Model 2 shows that the sign and statistical significance of the explanatory variables are similar to those obtained in Model 1. Specifically, both population and openness have a positive and statistically significant impact on SO_2

[12] One might question the validity of the baseline results as the estimate of the lagged of dependent variables is close to one, particularly in case of Model 2. However, this is not the case as I applied system GMM estimator which effectively accounts for persistence in dependent variable. For further ensuring the validity of the estimates, I have run a Fisher-type panel unit root test. The test does not provide any significant evidence of the existence of unit root problems in the underlying series.

emissions while the impact of youth is statistically insignificant. The main difference between CO_2 and SO_2 concerns the tipping point of the EKC. Specifically, the estimated income turning point is higher for CO_2 (10.6) than for SO_2 (9). This finding is consistent with Cavlovic *et al*. (2000) and Managi *et al*. (2009) who also show that the peak of CO_2 emissions occurs at relatively higher level of incomes compared to SO_2 emissions.[13]

Do the Determinants of Emissions have Political Regime-Dependent Effects?

In this subsection, I proceed to assess whether the impact of the underlying explanatory variables on emission levels vary across democratic and non-democratic regimes. The results are given in Table 4.6. In Model 1, the dependent variable is CO_2, while, in Model 2, the dependent variable is SO_2.

The results from the diagnostic tests provided in Panel B of Table 4.6 detect no statistical problems with the estimator. Specifically, the estimates of *J*-test provide evidence that the orthogonality condition is satisfied. Further, the Arellano-Bond test shows that the residuals exhibit no second-order serial correlation.

To check whether the estimated coefficients are statistically different across the two political regimes I have run a Wald-type test. The test statistic (*p*-value) for CO_2 is 2.16 (0.062), and for SO_2 is 2.75 (0.022). Thus, the null hypothesis of equality of coefficients can be rejected in favour of the alternative hypothesis of the underlying estimates being statistically different across democracies and non-democracies (detailed results are shown in Appendix in Table C.3).

The results of Model 1 indicate that the level of per capita GDP has a positive and statistically significant impact on emission levels across both political regimes. This implies that an increase in the level of per capita GDP causes increases in levels of emission regardless of whether the economy has democratic or non-democratic institutions. As can be seen from the table, the negative coefficient of the square term of per capita GDP is statistically significant for democracies whereas the corresponding

[13] The turning points are the points where the first derivative of the estimated model with respect to per capita GDP is equal to 0.

coefficient for dictatorships fail to achieve any conventional level of statistical significance. [14] This means that the relationship between emission levels and GDP has a turning point only in democracies, approximately at 11 (in log terms).

Table 4.6: System GMM Estimates on the Determinants of CO_2 and SO_2 - Differential Effects across Political Regimes

Panel A: Estimation Results		
	Model 1 (CO_2)	**Model 2 (SO_2)**
$PR^{D}_{i.t} \cdot GDP_{i.t}$	0.528** (0.203)	0.291** (0.120)
$PR^{N}_{i,t} \cdot GDP_{i,t}$	0.481** (0.241)	0.409** (0.163)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.024** (0.011)	-0.015** (0.007)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.021 (0.015)	-0.023** (0.010)
$PR^{D}_{i,t} \cdot Pop_{i,t}$	0.117*** (0.032)	0.037*** (0.013)
$PR^{N}_{i,t} \cdot Pop_{i,t}$	0.123*** (0.044)	0.027** (0.013)
$PR^{D}_{i,t} \cdot Youth_{i,t}$	0.023 (0.058)	0.091 (0.068)
$PR^{N}_{i,t} \cdot Youth_{i,t}$	0.014 (0.099)	0.012 (0.057)
$PR^{D}_{i,t} \cdot Open_{i,t}$	0.074** (0.031)	0.039* (0.023)
$PR^{N}_{i,t} \cdot Open_{i,t}$	0.110*** (0.032)	0.041** (0.019)
$E_{i,t-1}$	0.911*** (0.025)	0.979*** (0.010)
Trend	-0.003*** (0.001)	-0.002*** (0.001)
Constant	-3.961*** (1.141)	-2.229*** (0.659)
Panel B: Diagnostic Tests		
AR(2)	0.442	0.927
Hansen test	0.207	0.577
Observations	5222	4047
Countries	138	116
Instruments	95	74

Notes: The table shows the main determinants of emission levels conditional to the political regime, i.e. Democracy $\left(PR^{D}_{i,t}\right)$ and Dictatorship $\left(PR^{N}_{i,t}\right)$. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Model 1 shows the estimates for CO_2 emissions and Model 2 shows the estimates for SO_2 emissions. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

One potential explanation behind the lack of evidence for an EKC in non-democracies is that democracies promote stronger multilateral environmental cooperation than non democracies (Neumayer, 2002). This is especially important for curbing CO_2 emissions due to their nature of global externality. However, the number of year-observations

[14] It is interesting to note that there are two dictatorships (year-observations) with per capita GDP above 11, namely Qatar and Brunei. However, the turning point of the EKC for dictatorship is slightly higher, approximately 11.45. Above this level there are only two year-observations, namely Qatar-2006 and Qatar-2007.

above the turning points is extremely small and regards Luxembourg only. Thus, the estimate cannot be taken as reliable evidence in favour of an EKC for CO_2 emissions. As regards non-democracies the coefficient of the per capita GDP squared term is not statistically significant.

One difference worth noting is that the turning point for SO_2 is lower for non-democracies than for democracies (8.9 and 9.7, respectively). As for the remaining coefficients, both signs and statistical significance are similar across political regimes. Thus, in terms of economic significance, the results so far provide little evidence for a differential impact of the driving forces across political regimes.

Do the Differential Effects across Political Regimes Differ across Income Levels?

In this section, I investigate whether the differential effects of the underlying determinants of emissions across political regimes vary with the level of income. The results are shown in Table 4.7.[15] The sign and statistical significance of per capita GDP and its square terms remain unchanged.

Because of the presence of interactions with per capita GDP, the estimates of elasticity of emission levels with respect to population, youth and openness depend on income levels. Consequently, the elasticity cannot be measured directly by observing only the magnitude of the corresponding coefficient. However, it is possible to calculate the elasticity by taking the partial derivative of Equation (3) with respect to a specific underlying explanatory variable. This allows us to assess the sensitivity of emissions with respect to population, youth and openness at different percentiles of income (per capita GDP). Tables 4.8 and 4.9 present the elasticity of CO_2 and SO_2 emissions, respectively. For visual analysis of the sensitivity of the CO_2 and SO_2 emissions, the estimates given in Tables 4.8 and 4.9 are plotted in Figures 4.1 to 4.6 (in Appendix).

[15] The Wald-type test rejects the null hypothesis that estimated coefficients are not statistically significant different across the two political regimes. Results are shown in Table C.3 (Appendix).

Population

Model 1 in Table 4.7 shows that the positive impact of increasing levels of population on CO_2 emissions weakens as a country achieves higher levels of income regardless of the political regime. These estimates implies that the adverse impact of population on air quality is likely to be less severe in economies that have high levels of per capita GDP as compared to those that have lower levels of income. This finding provides evidence supporting the Boserupian perspective that population growth prompts technological advances which counterbalance the adverse effect of increasing levels of population on the environment. Further, this result is in line with the empirical evidence in Shi (2003) and Martínez-Zarzoso *et al*. (2007) who indicate a weaker impact of population on CO_2 in high income countries as compared to relatively poorer countries. Interestingly, the elasticity of SO_2 with respect to population turns from positive to negative at and above the 70^{th} percentile of income in both political regimes (Table 4.9 and Figure 4.4). This means that at relatively high income levels, further increases in population size are associated with lower levels of SO_2 emissions.

As regards the differential impact across democracies and dictatorships, the results show that the sensitivity of CO_2 emission levels to population size is approximately the same across political regimes at relatively low income levels (Table 4.8 and Figure 4.1). On the other hand, emission levels are more sensitive to population size in democracies than in non-democracies at higher levels of income. These figures mean that rising levels of population are less harmful in terms of CO_2 emissions for dictatorships as compared to democracies at high income percentiles. As for SO_2, the elasticity of emissions in absolute terms is higher in the case of non-democracy throughout the range of income (Table 4.9 and Figure 4.4). According to the sign of elasticity, the results reveal that a growth in population size is more detrimental under dictatorship than under democracies in the range of relatively low income levels. Conversely, at higher income levels, rising levels of population turn out to be more "beneficial" for dictatorship as compared to democracies.

Table 4.7: System GMM Estimates on the Determinants of CO_2 and SO_2 - Differential Effects across Political Regimes Conditional on Income Levels

Panel A: Estimation Results		
	Model 1 (CO_2)	**Model 2 (SO_2)**
$PR^{D}_{i.t} \cdot GDP_{i.t}$	1.843** (0.756)	2.686** (1.163)
$PR^{N}_{i,t} \cdot GDP_{i,t}$	1.749** (0.796)	2.810*** (1.031)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.045** (0.021)	-0.073** (0.035)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.020 (0.024)	-0.069*** (0.024)
$PR^{D}_{i,t} \cdot Pop_{i,t}$	0.281*** (0.090)	0.292** (0.116)
$PR^{N}_{i,t} \cdot Pop_{i,t}$	0.339** (0.141)	0.511*** (0.186)
$PR^{D}_{i,t} \cdot Youth_{i,t}$	1.036 (0.739)	1.686 (1.069)
$PR^{N}_{i,t} \cdot Youth_{i,t}$	1.196 (0.921)	0.991 (1.134)
$PR^{D}_{i,t} \cdot Open_{i,t}$	0.591*** (0.222)	0.611** (0.275)
$PR^{N}_{i,t} \cdot Open_{i,t}$	0.573** (0.240)	0.565** (0.255)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Pop_{i,t}$	-0.020** (0.009)	-0.030** (0.013)
$PR^{N}_{i,t} \cdot GDP_{i,t} \cdot Pop_{i,t}$	-0.032** (0.016)	-0.061*** (0.023)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Youth_{i,t}$	-0.123 (0.083)	-0.183 (0.122)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Youth_{i,t}$	-0.149 (0.104)	-0.115 (0.131)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Open_{i,t}$	-0.062** (0.025)	-0.070** (0.031)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Open_{i,t}$	-0.061** (0.029)	-0.069** (0.032)
$E_{i,t-1}$	0.916*** (0.025)	0.970*** (0.019)
Trend	-0.002*** (0.001)	-0.001 (0.001)
Constant	-13.414*** (5.100)	-18.506** (7.515)
Panel B: Diagnostic Tests		
AR(2)	0.438	0.922
Hansen test	0.341	0.591
Observations	5222	4047
Countries	138	116
Instruments	129	75

Notes: The table shows the main determinants of emission levels conditional to the political regime and the level of income $(GDP_{i,t})$. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Model 1 shows the estimates for CO_2 emissions and Model 2 shows the estimates for SO_2 emissions. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table 4.8: Elasticity of CO_2 with respect to Selected Variables

					Panel A: Democracy				
	P10	**P20**	**P30**	**P40**	**P50**	**P60**	**P70**	**P80**	**P90**
Pop	0.128	0.116	0.107	0.100	0.094	0.086	0.081	0.077	0.072
Youth	0.108	0.038	-0.021	-0.062	-0.096	-0.146	-0.175	-0.200	-0.229
Open	0.125	0.090	0.060	0.039	0.022	-0.003	-0.017	-0.030	-0.044
					Panel B: Dictatorship				
	P10	**P20**	**P30**	**P40**	**P50**	**P60**	**P70**	**P80**	**P90**
Pop	0.129	0.121	0.111	0.102	0.091	0.079	0.069	0.058	0.041
Youth	0.229	0.191	0.147	0.104	0.055	0.001	-0.048	-0.098	-0.177
Open	0.176	0.161	0.143	0.126	0.106	0.083	0.063	0.043	0.010

Notes: The table reports the elasticities of CO_2 with respect to Population, Youth and Openness across different percentiles of per capita GDP. Panel A reports the elasticities for Democracy. Panel B reports the elasticities for Dictatorship.

Table 4.9: Elasticity of SO_2 with respect to Selected Variables

					Panel A: Democracy				
	P10	**P20**	**P30**	**P40**	**P50**	**P60**	**P70**	**P80**	**P90**
Pop	0.064	0.045	0.033	0.025	0.016	0.005	-0.001	-0.006	-0.013
Youth	0.284	0.166	0.093	0.039	-0.015	-0.079	-0.119	-0.152	-0.192
Open	0.073	0.028	0.000	-0.020	-0.041	-0.066	-0.081	-0.094	-0.109
					Panel B: Dictatorship				
	P10	**P20**	**P30**	**P40**	**P50**	**P60**	**P70**	**P80**	**P90**
Pop	0.108	0.085	0.067	0.050	0.028	0.011	-0.008	-0.029	-0.056
Youth	0.226	0.181	0.147	0.114	0.074	0.041	0.005	-0.035	-0.087
Open	0.107	0.080	0.060	0.040	0.016	-0.003	-0.025	-0.049	-0.080

Notes: The table reports the elasticities of SO_2 with respect to Population, Youth and Openness across different percentiles of per capita GDP. Panel A reports the elasticities for Democracy. Panel B reports the elasticities for Dictatorship.

There are no straight theoretical reasons which could account for such a differential effects across political regimes. It could be argued that such difference in sensitivity is driven by an income difference *between* political regimes. After all, a relatively rich (poor) democracy has a higher income level than a relatively rich (poor) dictatorship. However, the findings suggest that the income level works as a *mitigating* factor of the adverse impact of population. If the results are simply the artefact of income differences between political regimes, then the adverse (beneficial) effect of increasing levels of population should be generally weaker (stronger) in democracies than in dictatorships. However, the results show that the opposite is true.

Youth

As can be seen from Table 4.7, the sign of the coefficient related to youth is positive, yet the interaction term with per capita GDP is negative. This suggests that the change in CO_2 emissions following a change in the share of young population would be bigger in poorer countries than in rich countries, regardless of political regime. Yet, the coefficients of both youth and its interaction with per capita GDP are statistically insignificant.

These findings provide little support for intergenerational environmental altruism whereby parents start to pursue their desire to preserve the environment for the young generations as a society achieves sufficiently high living standards. These results hold for both political regimes, which suggest that there is no differential impact across democracies and dictatorships.

Openness

The estimate involving per capita GDP interacted with the proxy of trade openness shows that the positive effect of openness on CO_2 emissions decreases as the level of income increases (Table 4.7). This observation is robust across both political regimes. The negative sign of the interaction term can be considered as evidence supporting the PPH. That is, tighter environmental standards and relatively strong preference about environment quality at higher income levels might have prompted the migration of dirty

industries from relatively richer countries to their trading partners that are poor economically.

In such a scenario, it is obvious to expect that the adverse environmental impact, particularly air pollution, of trade openness would be more manifest in countries having relatively lower levels of income. This result is also in line with previous findings of pollution heaven effects (Lucas *et al*., 1992; Mani and Wheeler, 1998; and Cole and Elliot, 2003). The estimates of elasticity related to trade openness show that the elasticity of CO_2 emissions change its sign, turning positive to negative at and above the 60^{th} percentile for democracies (Table 4.8 and Figure 4.3). I also observe that, contrary to CO_2 emissions, the sensitivity of SO_2 to openness turns out to be negative at relatively high income levels, regardless of the political regime (Table 4.9 and Figure 4.6).

As regards the differential impact across political regime, the elasticities show that pollution heaven effects are stronger for democracies as compared to non-democracies. This result has potentially important implications for the debate on the impact of democracy on environmental quality. Specifically, the beneficial impact of democracy on environmental quality found by previous studies might be partially driven by pollution heaven effects. In other words, the curbing effect on emissions associated with higher degrees of democracy could mask the migration of dirty production toward developing countries with weak environmental regulations. This suggests that democratic regimes, presumably, provide only partial solutions to environmental problems, leaving them largely untouched on a global scale.

4.5.3. Robustness Check

In this section I check whether the statistical estimates are driven by any specific observation. As shown by Dietz and Rosa (1997), regressions analyses of air pollution could be strongly influenced by the two most populated countries, namely China and India. Means and standard deviations for these countries are displayed in Table C.4 (Appendix). As can been seen, the average of CO_2, SO_2 and population for these two countries are relatively high as compared to the averages shown in Tables 4.1-4.2.

Therefore I drop China and India from the panel and re-estimate Models 1-2 of Table 4.7. The results are showed in Table C.5 in Appendix. The exclusion of these countries scarcely affects the findings. Specifically, the signs and statistical significance of the coefficients on population and openness, as well as their interactions with per capita GDP, are preserved.

As an additional robustness check I drop the United States from the panel of countries. Being one of the most polluting countries in the world, one might expect that the US would affect the findings for democracies. Mean and standard deviation are presented in Table C.4. Table C.6 in Appendix illustrates the empirical estimations. Estimates are robust to the exclusion of the US with the exception of the proportion of population aged less than 15 for SO_2 emissions (Model 2). Specifically, the coefficients of youth as well as its interaction with income levels are now both statistically significant at 5% for democracies. In line with previous results, I find that the sign of the overall impact of youth on SO_2 emissions turns from positive to negative as the income level of a nation increases.[1]

These findings provide some evidence in favour of intergenerational environmental altruism in democracies. This might be due to free flow of information and the work of environmental lobbies which strengthen parents' determination to leave a better environment for their children. However, the impact of youth on CO_2 emissions remains insignificant regardless of the political regime. One possible explanation for these asymmetric findings between air pollutants is that the adverse effects of CO_2 on environment and human health are less visible as compared to those of SO_2 (e.g. Managi *et al*., 2009).

4.6. Conclusions

Over the last couple of decades, much theoretical work has been devoted to understanding the factors behind emissions of CO_2 and SO_2 across the globe. Empirically, several studies have documented that production levels, international trade activities, age structure, urbanization and economic growth are the most significant

[1] The income turning point for democracies is just below the 50th percentile (results not shown here).

determinants of the level of emissions. Further, some prior studies have also found that democracy plays an important role in affecting emissions. However, the existing literature does not explore whether the adverse (beneficial) effects of the driving forces are weaker (stronger) in democracies as compared to dictatorships. The main aim of this study is to investigate the differential effects on emission levels of per capita GDP, population size, the share of population aged less than 15 and trade openness, across democratic and non-democratic countries.

The main findings from my empirical investigation show that the impact of population, youth and openness on emission levels varies across political regimes. As regards population, democracies do not appear to mitigate the adverse impact of an increasing number of people as compared to dictatorships.[2] In fact, population pressures appear to be less problematic precisely in dictatorships. As regards openness, the results indicate that the adverse effects associated with higher shares of trade are generally weaker under democracies than under dictatorships.[3] However, the negative sign of the interaction term between openness and per capita GDP suggests that such differential impact across political regimes reflects pollution heaven effects. Finally, my findings display that the share of young population has a significant impact on emissions levels of SO_2 for democracies (when the US excluded). The negative sensitivity of SO_2 to youth suggests that democracy promotes intergenerational altruism at relatively high levels of income.

Taken together, the findings provide some interesting insights into the potential role played by the political regime in addressing environmental issues. The results on the impact of youth suggest that individuals in democracies are more concerned with the welfare of future generations then elites in non-democracies. The attributes of democratic institutions, such as civil rights and freedom of information and expression, probably underlie this difference across political regimes. On the other hand, other results cast some doubts on the capability of democracies to effectively address environmental problems. First, increasing levels of population seem generally less detrimental on air quality in dictatorships than in democracies. Second, contrary to the case of SO_2, there is little evidence of intergenerational altruism for a global pollutant

[2] A weaker adverse impact means a stronger beneficial impact in the income range where the elasticity turns from positive to negative.
[3] Like population, a weaker adverse impact of openness means a stronger beneficial impact where the elasticity turns to be negative.

such as CO_2 emissions, regardless of the political regime. Third, the results on trade openness suggest that strong pollution abatements observed in relatively rich countries could be partially offset by pollution heaven effects and such effects are stronger under democracies. This last finding implies that the beneficial environmental impact of democracy found in previous studies might, in fact, partially reflect an externalization of environmental problems toward poor countries.

Overall, these findings call for some caution about strong statements which emphasize the ability of democracy in solving environmental problems on a global scale. Most of the empirical evidence on such view comes from studies based on models which link a democracy variable directly to environmental output. In fact, to deliver better environmental outcomes democracy needs to have some kind of control over the environmental impact of other factors. It is likely that the relationship between democracy and environmental issues is more complex than empirical models so far have supposed. Further research with emphasis on the channels linking democracy to environmental pollution is needed to ascertain the impact of democracy on the environment.

4.7. Appendix C

Table C.1: Description of Variables

Variable	Description	Source
SO_2	Carbon Dioxide emissions (Units: Gigagram).	Smith *et al*. 2010 Available at: http://ciera-air.org
PR	Political Regime Index (Dummy Variable)	Cheibub *et al*. 2010 Available at: https://netfiles.uiuc.edu/cheibub
GDP	Real GDP per capita (Constant Prices: Chain series)	Penn World Table 6.3
Open	Sum of exports and imports of goods and services (% of GDP)	
CO_2	Carbon Dioxide emissions (Units: Kilotons).	World Bank Available at: http://www.esds.ac.uk/international/website
Pop	Population, total	
Youth	Population aged 0-14 (% of total)	

Table C.2: List of Countries

Afghanistan	Egypt	Malawi	South Africa
Albania	El Salvador	Malaysia	Spain
Algeria	Estonia	Maldives	Sri Lanka
Argentina	Fiji	Mali	Sudan
Armenia	Finland	Malta	Swaziland
Australia	France	Mauritania	Sweden
Austria	Gabon	Mauritius	Switzerland
Bahrain	Gambia	Mexico	Syria
Bangladesh	Ghana	Moldova	Tajikistan
Barbados	Greece	Mongolia	Tanzania
Belgium	Guatemala	Morocco	Thailand
Belize	Guyana	Mozambique	Togo
Benin	Haiti	Namibia	Tonga
Bolivia	Honduras	Nepal	Trinidad & Tobago
Botswana	Hungary	Netherlands	Tunisia
Brazil	Iceland	New Zealand	Turkey
Brunei	India	Nicaragua	Uganda
Bulgaria	Indonesia	Niger	Ukraine
Burundi	Iran	Norway	UAE
Cambodia	Iraq	Pakistan	United Kingdom
Cameroon	Ireland	Panama	United States
Canada	Israel	Papua New Guinea	Uruguay
Central African Rep.	Italy	Paraguay	Venezuela
Chile	Jamaica	Peru	Vietnam
China	Japan	Philippines	Yemen
Colombia	Jordan	Poland	Zambia
Congo	Kazakhstan	Portugal	Zimbabwe
Congo, Dem. Rep.	Kenya	Qatar	
Costa Rica	Korea, South	Romania	
Cote d'Ivoire	Kuwait	Russia	
Croatia	Kyrgyzstan	Rwanda	
Cuba	Laos	Saudi Arabia	
Cyprus	Latvia	Senegal	
Czech Republic	Liberia	Sierra Leone	
Denmark	Libya	Singapore	
Dominican Republic	Lithuania	Slovakia	
Ecuador	Luxembourg	Slovenia	

Notes: The table illustrates the sample of countries used in the empirical investigation. Data on SO_2 emissions are unavailable for 22 countries of the 138 countries listed.

Table C.3: Chow Test for Testing Equality of Coefficients across Political Regimes

	CO_2	SO_2
	Equation (2)	
F-test	2.16	2.75
p-value	0.062	0.022
	Equation (3)	
F-test	2.08	3.19
p-value	0.041	0.003

Notes: The table reports the Chow tests results from Equations (2) and (3). The null hypothesis is that the estimated coefficients are not jointly statistically different across democracies and dictatorships.

Table C.4: Summary Statistics for China, India and the US

Variables	Country	CO_2 Sample		SO_2 Sample	
		Mean	Std. Dev.	Mean	Std. Dev.
CO_2	China	14.323	0.799		
	India	13.040	0.784		
	US	15.352	0.177		
SO_2	China			9.424	0.578
	India			7.690	0.675
	US			9.977	0.248
GDP	China	7.376	0.654	7.316	0.599
	India	7.107	0.378	7.069	0.338
	US	10.216	0.289	10.195	0.278
Pop	China	20.729	0.211	20.717	0.208
	India	20.415	0.283	20.396	0.275
	US	19.283	0.145	19.272	0.139
Youth	China	3.458	0.208	3.476	0.194
	India	3.642	0.073	3.649	0.065
	US	3.172	0.138	3.178	0.137
Open	China	2.912	0.708	2.853	0.664
	India	2.970	0.412	2.934	0.383
	US	2.640	0.415	2.609	0.397

Notes: The table illustrates the means and standard deviations of the variables under analysis for China, India and the US.

Table C.5: System GMM Estimates on the Determinants of CO_2 and SO_2 - China and India excluded

Panel A: Estimation Results		
	Model 1 (CO_2)	**Model 2 (SO_2)**
$PR^{D}_{i,t} \cdot GDP_{i,t}$	2.321***(0.766)	2.196** (0.961)
$PR^{N}_{i,t} \cdot GDP_{i,t}$	2.164***(0.810)	2.282***(0.763)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.046**(0.022)	-0.050*(0.030)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.025(0.026)	-0.049*** (0.019)
$PR^{D}_{i,t} \cdot Pop_{i,t}$	0.417*** (0.128)	0.451*** (0.139)
$PR^{N}_{i,t} \cdot Pop_{i,t}$	0.501** (0.198)	0.264** (0.123)
$PR^{D}_{i,t} \cdot Youth_{i,t}$	1.009 (0.712)	0.767 (0.974)
$PR^{N}_{i,t} \cdot Youth_{i,t}$	1.277 (0.915)	1.569 (1.250)
$PR^{D}_{i,t} \cdot Open_{i,t}$	0.994*** (0.294)	0.594*** (0.209)
$PR^{N}_{i,t} \cdot Open_{i,t}$	0.673** (0.290)	0.684** (0.331)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Pop_{i,t}$	-0.035** (0.014)	-0.046*** (0.014)
$PR^{N}_{i,t} \cdot GDP_{i,t} \cdot Pop_{i,t}$	-0.049** (0.023)	-0.031** (0.014)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Youth_{i,t}$	-0.128 (0.081)	-0.082 (0.110)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Youth_{i,t}$	-0.147 (0.104)	-0.165 (0.135)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Open_{i,t}$	-0.110***(0.034)	-0.068***(0.023)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Open_{i,t}$	-0.073** (0.036)	-0.083** (0.041)
$E_{i,t-1}$	0.893*** (0.032)	0.973*** (0.018)
Trend	-0.002* (0.001)	-0.000 (0.001)
Constant	-17.071*** (5.147)	-16.163** (6.191)
Panel B: Diagnostic Tests		
AR(2)	0.458	0.929
Hansen test	0.211	0.560
Observations	5132	3963
Countries	136	114
Instruments	126	75

Notes: The table shows the main determinants of emission levels conditional to the political regime and the level of income. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Model 1 shows the estimates for CO_2 emissions and Model 2 shows the estimates for SO_2 emissions. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. China and India are excluded from the sample. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Table C.6: System GMM Estimates on the Determinants of CO_2 and SO_2 - the US excluded

Panel A: Estimation Results		
	Model 1 (CO_2)	**Model2 (SO_2)**
$PR^{D}_{i,t} \cdot GDP_{i,t}$	1.968** (0.839)	2.798*** (0.896)
$PR^{N}_{i,t} \cdot GDP_{i,t}$	1.854** (0.904)	2.913*** (0.791)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.048** (0.024)	-0.076** (0.029)
$PR^{D}_{i,t} \cdot GDP^{2}_{i,t}$	-0.022 (0.027)	-0.069*** (0.021)
$PR^{D}_{i,t} \cdot Pop_{i,t}$	0.285*** (0.096)	0.309*** (0.108)
$PR^{N}_{i,t} \cdot Pop_{i,t}$	0.371*** (0.139)	0.494*** (0.138)
$PR^{D}_{i,t} \cdot Youth_{i,t}$	1.176 (0.843)	1.815** (0.885)
$PR^{N}_{i,t} \cdot Youth_{i,t}$	1.238 (1.075)	1.333 (0.938)
$PR^{D}_{i,t} \cdot Open_{i,t}$	0.580** (0.239)	0.576*** (0.214)
$PR^{N}_{i,t} \cdot Open_{i,t}$	0.567** (0.246)	0.530** (0.250)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Pop_{i,t}$	-0.021** (0.010)	-0.032*** (0.011)
$PR^{N}_{i,t} \cdot GDP_{i,t} \cdot Pop_{i,t}$	-0.036** (0.016)	-0.059*** (0.017)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Youth_{i,t}$	-0.140 (0.094)	-0.196** (0.098)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Youth_{i,t}$	-0.154 (0.124)	-0.159 (0.109)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Open_{i,t}$	-0.061** (0.027)	-0.065*** (0.024)
$PR^{D}_{i,t} \cdot GDP_{i,t} \cdot Open_{i,t}$	-0.061** (0.029)	-0.064** (0.031)
$E_{i,t-1}$	0.916*** (0.026)	0.973*** (0.019)
Trend	-0.002** (0.001)	-0.001 (0.001)
Constant	-14.169** (5.677)	-19.293*** (5.730)
Panel B: Diagnostic Tests		
AR(2)	0.441	0.920
Hansen test	0.249	0.553
Observations	5177	4005
Countries	137	115
Instruments	129	77

Notes: The table shows the main determinants of emission levels conditional to the political regime and the level of income. Panel A reports the estimates obtained from robust two-step system GMM estimations. The figures given in parentheses are standard errors which are asymptotically robust to the presence of heteroskedasticity and serial correlation within panels. Model 1 shows the estimates for CO_2 emissions and Model 2 shows the estimates for SO_2 emissions. Panel B reports the *p*-values of the Hansen test and the Arellano and Bond test. The United States are excluded from the sample. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

Figure 4.1: Elasticity of CO_2 with respect to Population across Income Percentiles

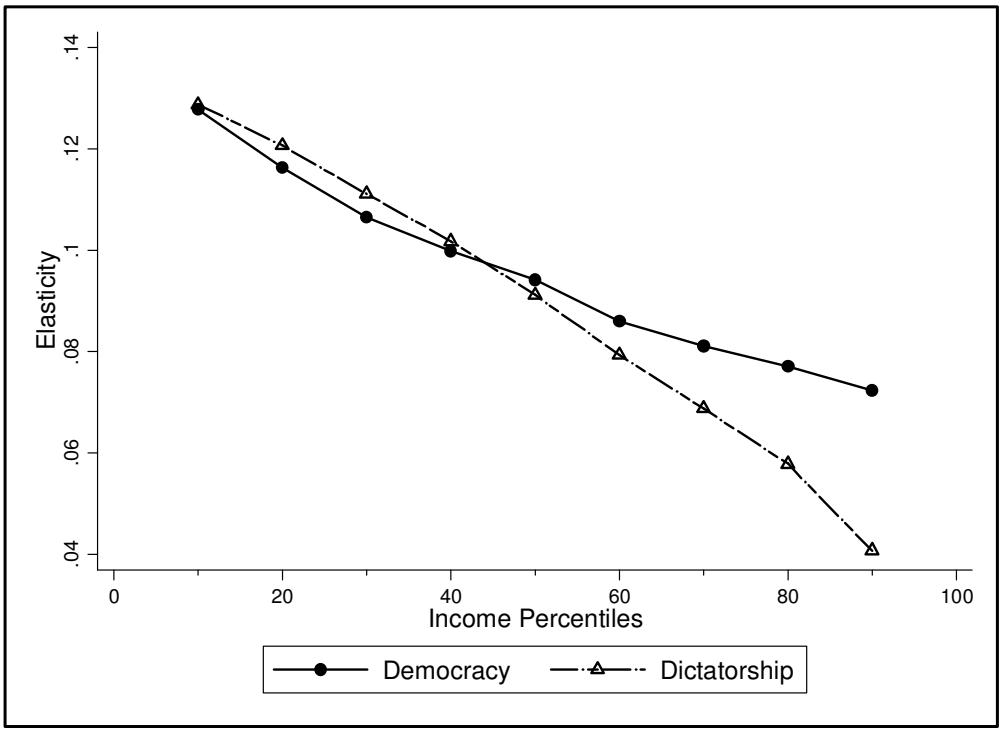


Figure 4.2: Elasticity of CO_2 with respect to Youth across Income Percentiles

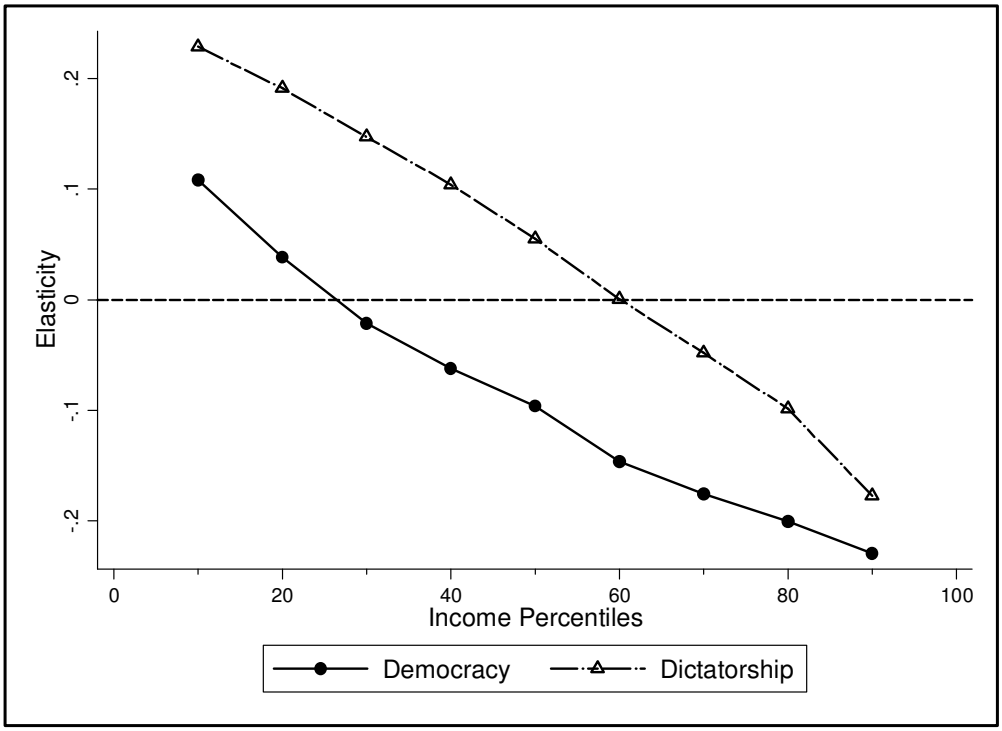


Figure 4.3: Elasticity of CO_2 with respect to Openness across Income Percentiles

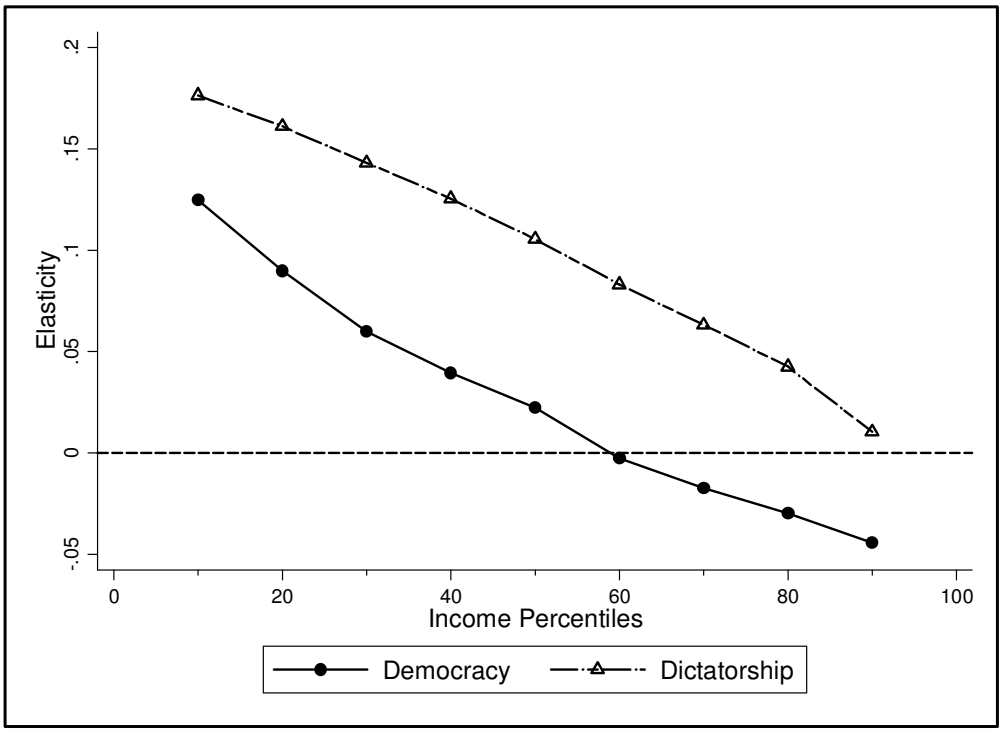


Figure 4.4: Elasticity of SO_2 with respect to Population across Income Percentiles

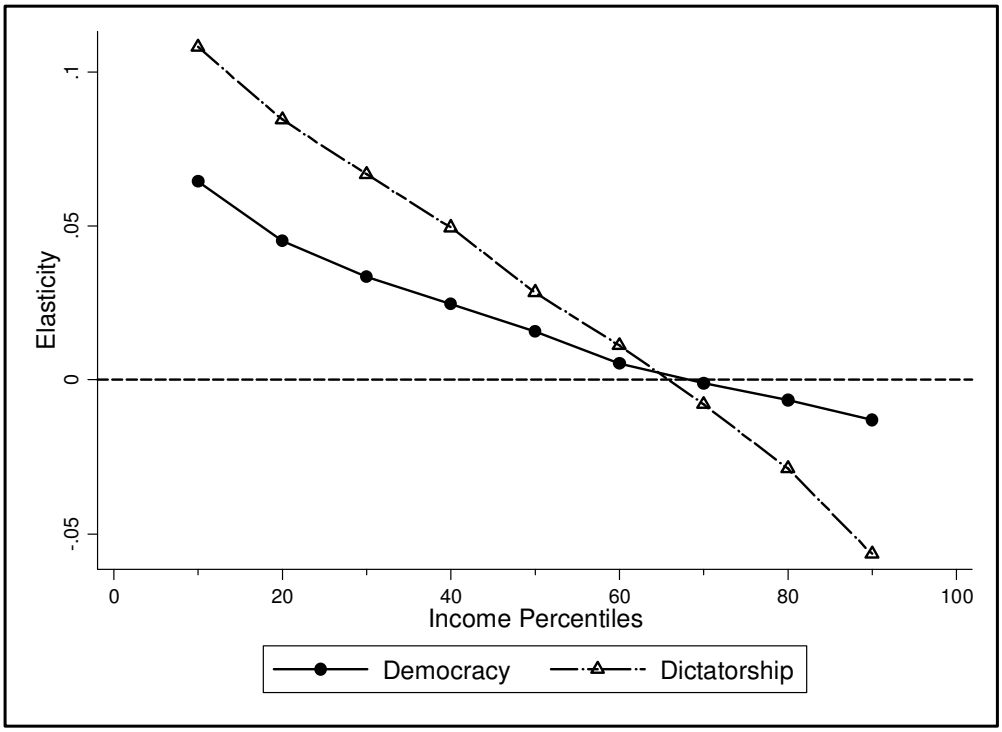


Figure 4.5: Elasticity of SO_2 with respect to Youth across Income Percentiles

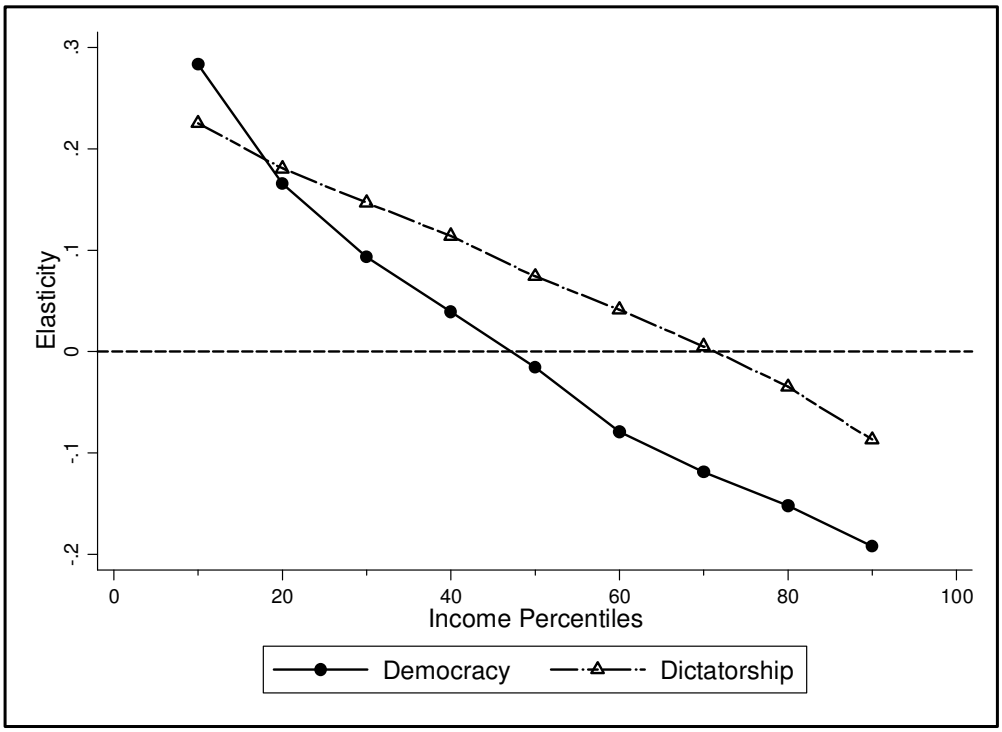
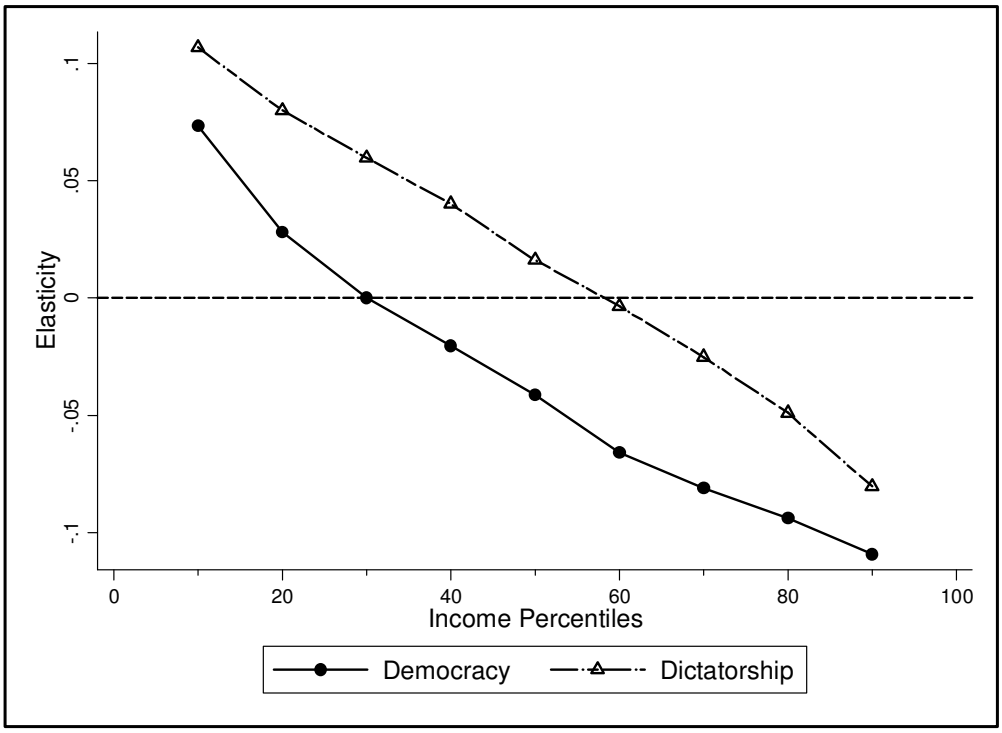


Figure 4.6: Elasticity of SO_2 with respect to Openness across Income Percentiles



Chapter 5 : Conclusion

This thesis has explored the theme revolving on the relationship between growth, poverty and air pollution, on the one hand, and a specific set of institutions, on the other hand. Economic growth, alleviation of poverty and environmental quality, all sound as attractive targets to be achieved. Similarly, the institutions under analysis have some inherently desirable characteristics which make them a target by their own. Specifically, the one person/one vote principle entails, at least in theory, an egalitarian partition of the political power, thereby making democratic institutions the embodiment of political equity. The amelioration of information and transition costs, which characterizes an efficient financial sector, makes financial development a crucial factor for an efficient allocation of resources. Given these inherent aspects of equity and efficiency, it is fundamental to assess whether there is a trade-off between the institution and another desirable target, or, on the contrary, whether the institution is conducive to the achievement of that target. A third possibility is that the institution neither promotes nor hampers the accomplishment of the target, in which case it is simply "neutral".

Based on this, the current thesis has explored three themes: (i) the relationship between income inequality and growth conditional on the political regime; (ii) the impact of financial development on poverty; (iii) the differential effects of the factors underling CO_2 and SO_2 emissions across democracies and non-democracies. Specifically, Chapter Two assesses the differential impact of inequality on growth across political regimes by using new and more reliable dataset on inequality as well as modern methodological tools. Further, it adopts an empirical model which allows the impact of income inequality on growth to vary with the level of income. In Chapter Three, I assess the relationship between poverty and financial development using two measures of *absolute* poverty as well as a measure of *relative* poverty while overcoming some of the methodological problems encountered in previous studies. I also use different proxies of financial development which gauges two different dimension of financial development, i.e. the size of the financial sector and the efficiency/liquidity with which the financial sector performs its functions. In Chapter Four I quantify the impact of the main factors underlying CO_2 and SO_2 emissions, namely the level of income, population size, the proportion of population aged less than 15 and trade openness. After assessing the

effects of these variables for the full sample of countries, I explore whether these effects differ across political regimes, namely democracies vis-à-vis dictatorships.

The empirical results are summarized separately for each chapter in the following sections. Policy implications, limitations and scope for future research are illustrated in the final two sections.

Chapter 2: The Impact of Income Inequality on Growth: A Sensitiveness Analysis across Different Political Regimes

This chapter contributes to yield a better grasp of the relationship between inequality and growth by studying the effect of inequality on growth across different political regimes in the light of more reliable dataset on inequality, sophisticated methodological tools and a flexible functional form linking inequality to growth. The results show that the effects of income inequality on growth are negative and statistically significant regardless of the type of political regime. However, when the interaction term between the Gini index and per capita GDP is included in the set of regressors, the results show that while the overall impact of inequality on growth is negative for relatively low levels of income, it turns out to be positive at relatively high levels of income. As for the differential effect across political regime, the estimates obtained from employing the flexible functional form reveals that the effect of inequality on growth varies with income levels differently for democracies and dictatorships. Specifically, as far as relatively low-income countries are concerned, the results show that the overall impact of inequality on growth, which is of negative sign, is weaker under democracies than under dictatorships. On the other hand, the estimates display that the overall impact of inequality in rich countries, which is of positive sign, is stronger under dictatorships than under democracies.

A different attitude of political regimes toward redistributional issues coupled with credit market imperfections provides a potential explanation for such findings. Contrary to the predictions of the political economic model, redistribution has the potential to improve efficiency when markets do not work perfectly. In addition, social safety platforms might foster growth rate to the extent that they function as a tool to buy social peace. Thus the alleged vulnerability of democracy to pressures for redistribution

might turn to be a virtue rather than a weakness. Specifically, by redistributing resources from rich to poor households democratic regimes are capable of mitigating the adverse impact of inequality on growth which prevails at relatively low income levels. On the other hand, redistribution does not sort out similar benefits in high-income countries because credit market imperfections and social unrest there are much less serious than in poor countries. Persistent increasing level of social expenditure in rich countries could even yield losses in efficiency. This provides one possible explanation of why the positive impact of inequality on growth, which manifests at higher levels of income, is stronger under dictatorships than under democracies.

Chapter 3: Absolute Poverty, Relative Poverty and Financial Development

In this Chapter I have contributed to the small but increasing strand of literature on the linkage between financial development and poverty by using indices of both absolute and relative poverty while attempting to address some of the methodological difficulties which are present in previous studies. My results show that the impact of financial development on poverty alleviation is statistically significant when the amount of liquid liabilities and the value of credit to the private sector is used as proxy of financial development and poverty is measured either by the headcount index or the poverty gap at the $ 2 a day poverty line (absolute poverty). The results are robust to the poverty line of $ 1.25 per day. On the other hand, the findings yield no evidence for a significant impact of financial development on the income share of the poorest 20% of the population (relative poverty), whatever the proxy for financial development. The results also show that the commercial-central bank ratio has no significant effects on poverty reduction, regardless of the measure of poverty. Similarly, both stock market capitalization and turnover ratio do not appear to significantly affect the incidence of poverty.

These results provide some evidence that improvements in the financial system, measured in terms of a deepening in the banking sector, mitigate the liquidity constraints which prevent poor households from undertaking their investment projects. Thus, in line with previous empirical studies, my results corroborate a beneficial impact of financial development in terms of lower levels of absolute poverty. Specifically, an increase in the value of liquid liabilities and in the availability of credit granted by

financial intermediaries to the private sector is followed by a reduction of the number of households living under the poverty lines of $ 2 and $ 1.25 per day. Moreover, the estimates concerning the poverty gap tells that financial development also moderates the "depth" of poverty, which means that the household living below the poverty line becomes less poor. On the other hand, weak evidence for a significant impact of financial development on the income share of the poorest 20% of population shows that financial development does not favour disproportionately the poorest. Finally, my empirical results reveal that neither the development of stock market nor the extent to which credit is being allocated by commercial banks relatively to central banks has any effect on the poor, whatever the measure of poverty.

Chapter 4: Determinants of CO_2 and SO_2 Emissions: Empirical Evidence for Different Political Regimes

In this Chapter I have contributed to the literature on the democracy-environment nexus by assessing whether the impact of the driving forces underlying CO_2 and SO_2 emissions is heterogeneous across democracies and non-democracies. In so doing I also used a set of interaction terms to assess whether differences across political regimes vary with the level of income. The empirical results from the full sample are in line with previous studies. Specifically, increasing levels of population and openness lead to higher emissions, while the impact of youth is statistically insignificant. The relationship between per capita GDP and emissions appear to be inverted U shaped. When I move to political regime, I observe that the effects of per capita GDP, population size, youth and trade openness are similar across democracies and non-democracies. The only difference relies on the relationship between per capita GDP and CO_2 emissions, which is inverted U shaped for democracies, while it is linear for dictatorships. Sizeable differences across political regimes emerge, however, when the effects of the underlying determinants of air pollution are interacted with the level of income. Specifically, the estimates display that the adverse impact of increasing levels of population on air quality is generally less strong under dictatorships than under democracies. Conversely, the adverse impact of greater trade openness is stronger under dictatorships than under democracies. Finally, the impact of youth on SO_2 emissions turns to be statistically significant for democracies only while it remains insignificant for CO_2, regardless of the type of political regime.

The results on the impact of youth suggest that individuals in democracies are more concerned with the welfare of future generations then the ruling elites in non-democracies. Such more intense concern is likely to be the outcome of civil rights, freedom of information and social movement mobilizations which are all important attributes of democratic institutions. However, unlike SO_2, there is no evidence of intergenerational altruism for CO_2, regardless of the political regime. One explanation for this is that the adverse impact of CO_2 on the environment is harder to perceive as compared to SO_2 emissions. The sign and the statistical significance of the interaction term between openness and per capita GDP provide evidence in favour of the pollution heaven hypothesis. Interestingly, the pollution heaven effects are stronger (in absolute values) for democracies than for dictatorships. This finding suggests that previous empirical studies on the environmental impact of political institutions might have given an overly optimistic view of the effect of democracy on environmental quality. As regards for the differential impact of population across political regimes, the estimates indicate that population pressures generally appear to be less problematic in dictatorships. I have no good theoretical explanation which could account for such finding.

Discussion and Policy Implications

Looking at the findings obtained in the current thesis, one can infer that the institutions do not trade off with any of the respective targets under analysis. This means that a country can enjoy the benefit from creating (or maintaining) a desirable political or economic institution without paying any cost in terms of the specific target under study. Specifically, the promotion of political freedoms does not seem to come at the cost of a lower growth rate neither democratic institutions appear to entail higher levels of CO_2 and SO_2 emissions, as compared to their nondemocratic counterparts. Similarly, the promotion of a financial system which effectively mitigates information and transition costs does not seems to exacerbate poverty. Having made clear that the institutions under analysis entail no apparent costs, it is important to assess whether these institutions accommodate the achievement of a specific target or, alternatively, they are simply irrelevant (“neutral”).

Let us start from the role played by democracy in the relationship between inequality and economic growth. There is a largely shared view, known as the "Lee thesis", which advocates restraints on political freedoms as the necessary price that poor countries have to pay in order to embark their economy along a path of fast economic growth. This view is well exposed in Moyo's New York Times Bestsellers *Dead Aid:* "In a perfect world what poor countries at the lowest rungs of economic development need is not a multi-party democracy, but in fact a decisive benevolent dictator to push through the reforms required to get the economy moving" (2009, p. 42). The policy implications from my empirical findings are clearly in stark contrast with this view. Indeed, my results show that democracies, far from being a hindrance to a process of sustained growth, are in fact economically valuable precisely in relatively poor economies. By lowering the income of the decisive voter, a process of democratization would boost redistributive policies, which in turn will lead the economy to grow faster, even if they are financed through distortionary taxes. In fact, not only the incentive to invest by the poor, but also the incentive by the rich – who bear the main burden of taxation - will ultimately increase in a Keynesian context. The high propensity of consumption of the poor will indeed expand the level of the aggregate demand along with the level of production, thereby boosting the level of investment (the "acceleration" principle). To sum up, the self-interest of the median voter might paradoxically lead a democratic country to growth faster as compared to an autocracy whose leader fails to acknowledge the necessity of a platform of social spending as a remedy for market imperfections and social conflict. Hence, at least in poor countries, democratic institutions would provide a "win-win" strategy as far as the economic growth rate is concerned.

Next, let us discuss some insights underlying the analysis of the relationship between financial development and poverty alleviation. As already explained, in presence of financial market constraints the economic possibilities of an individual are strictly determined by her parental wealth, not by her inherent skills. Individuals who are unable to provide the required collateral remain poor, regardless of their talents. If financial development effectively mitigates credit constraints, then policies which promote financial development would prove to be a better alternative to non-lump sum redistribution of wealth from the rich to the poor, such as public-expenditure projects financed by progressive taxation (Beck *et al*., 2007). By implementing appropriate financial policies, the policy maker could prompt the investments by the poor without

worrying about the incentive to invest by the rich. My findings suggest that policies which deepen the banking sector are indeed likely to lower *absolute* poverty. On the other hand, the results also show that financial development does not appear to lower *relative* poverty, that is, it does not favour disproportionately the poorest 20% of the population. Rather, the poorest seem to benefit from financial development as much as anyone else. Therefore, whether financial development is a win-win strategy depends on the definition of poverty. To the extent that the policy maker aims at narrowing the income gap between the poor and the richer, it is unlikely that financial policies could replace fiscal policies entirely. A combination of the two types of policies probably provides a better recipe to tackle poverty. For example, an increase in public expenditure for education accompanied with a moderate liberalization of banking interest rate could lower the counting of people living the poverty line and at the same time increase the income share of the poorest fraction of the populations.

Finally, let us make some comments about the role played by democracy in shaping environmental output. As explained in the literature review, previous empirical works generally provide evidence in favour of beneficial impact of democratic institutions on environmental quality. Such empirical evidence supports the arguments in favour of democracy, fairly resumed in the former US presidential candidate's phrase "I have therefore come to believe that an essential prerequisite for saving the environment is the spread of democratic government to more nations of the world" (Gore, 1992, p. 179). In this view, political liberalization is a valuable tool in tackling the environmental issue. My empirical analysis provides mixed results in this regard. Empirical estimations yield evidence of an intergenerational environmental altruism in democracy. This suggests that free flow of information, accountability of the political class, independence of the media and other features of democratic institutions are likely to raise public awareness about environmental issues. However, other findings somehow dampen the enthusiasm about the capability of democracy to effectively tackle environmental issues. First, evidence of intergenerational environmental altruism in democracy has been found only for a local pollutant, SO_2 emissions, not for a global pollutant, CO_2 emissions. In addition, pollution heaven effects appear to be stronger in democracies, meaning that more stringent environmental regulations have the effect of relocating pollution-intensive industries to other (poorer) countries. These two finding somehow give credit to the sceptical view, expressed in Paehlke's words: "while economy and environment

are now global in character, democracy functions on only national and local decision levels" (1996, p. 28). Thus, whether democratization provide a win-win strategy in terms of environment is not easy to say. Addressing environmental problems on a global scale requires an international institution endowed with the political authority to enforce a common environmental policy. Without some kind of international authority, it seems to me, democracies are unlikely to effectively tackle environmental problems by themselves. On the other hand, by rising public awareness, democracy might make the single nations more willing to comply with environmental policies.

Limitations and future research

It is important to acknowledge that the empirical evidence presented here is subject to several limitations some of which have been already discussed. One limitation with Chapter Two and Four lies in their empirical design. It is well known that democracies are richer than dictatorships. This implies that the results obtained here are partially driven by differences in income levels *across* political regimes. This is problematic as it is not possible to disentangle such an effect from a "democracy" effect. One way to overcome this limitation is to carry natural policy experiments by focusing, for example, on a sub-sample of countries which changed political regimes and assess whether the relationship between the main variables of interest have changed aftermath of a democratization. This is a promising area for future research.

An additional limitation with Chapter Two is concerned with the hypothesis of a different sensitivity of the policy-maker toward public pressure for redistribution across political regimes. Specifically, in line with the endogenous redistribution model, I have assumed that redistributive policies are more likely to be carried in democracies than in dictatorships. Although this assumption is reasonable, it has to be nonetheless acknowledged that there is no reason to believe that dictatorships are systematically less involved in social spending as compared to democracies. After all, it is not surprising that a populist regime could pay more attention to redistributional issues than a democracy with a long history of right-wing ruling parties. Thus, in a subsequent work it would be interesting to compare the different categories of public expenditure, such as military and education expenditure, across democracy and dictatorships to assess the extent to which the political regime shapes the composition of public expenditure.

A further limitation is concerned with the measurement of financial development. The proxies used in the empirical analysis reflect mainly the depth of the financial sector. Specifically, the empirical findings suggest that a deepening in the financial sector, as proxied by liquid liabilities and private credit, is conducive to a lower level of (absolute) poverty. It would have been preferable to use indices which directly gauge how well the financial system performs functions, such as risk amelioration, saving mobilization and capital allocation. In fact, finding a proxy which captures more closely the development of financial system is a potential area for future research in itself. In addition, showing that financial development is pro-poor is not the end of the story. First, financial development might be achieved by difference means, such as interest rate liberalization and the 1:4 license employed in India. Second, financial development could sometime even be achieved by some kinds of financial restrictions, such as reserve and liquidity requirements (Arestis *et al*., 2002). Therefore, additional empirical research is needed to shed light on the policies to be implemented in order to effectively foster financial development.

An additional limitation is concerned with the high-frequency of observations which ignore long run effects. This is especially true in Chapter Four. The empirical model here specifies current yearly levels of CO_2 and SO_2 emissions as a function of current yearly levels of the explanatory variables. Thus, in order to play any significant role in the preservation of the environment, democracies should have an immediate effect on the impact of the driving forces underlying emissions. However, it could be argued that the main effects of democracy might need time before they manifest. In order to capture a long-run impact, it would be interesting to consider the country's experience with democracy. This could be an interesting area to be investigated in future research. One final comment about the democracy-environment nexus is worth making. In Chapter Four I have assessed the role of democracy in environmental issues using a set of interaction term between driving forces and dummies for the political regime. Additional insights in such matter could be gained by assessing the extent to which democracy itself affect the driving forces. Future work which sheds light on the indirect effects of political regime is a promising line of research for a better understanding of the role played by democracy in environmental issues.

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