ESSAYS ON ECONOMIC GROWTH AND DEVELOPMENT IN LATIN AMERICA

Osvaldo Yasser Lagares Feliz

PhD

University of York
Economics

September 2015

Abstract

The economic growth and development process of the Latin American economies has been historically uneven. The persistent differences in per capita income growth and technological progress appears to be largely attributable to differences in economic policy. This thesis examines the growth effects of exchange rate variations, currency misalignments and nominal exchange rate regimes on productivity growth, the role of capital accumulation on economic growth and relative income differences, and the role of inflation thresholds on economic growth in thirty-two Latin American economies over a period of fifty years from 1960 to 2010.

Our methodology implements the system generalized method of moment's estimation approach for dynamic panel data models of productivity and economic growth where the growth determinants are crucially assumed endogenous to the growth process. In addition, we implement the novel dynamic panel threshold estimation methodology to growth models. We carry out these estimations using our new and extended macroeconomic dataset for the region.

The main original contributions of this thesis are as follow. In Chapter 2 we show that real exchange rate depreciations and exchange rate volatility have a contractionary effect on productivity growth in Latin America. In addition, we find evidence on the neutrality of currency misalignments and nominal exchange rate regimes in explaining productivity variations. However, our results show that currency undervaluations and flexible exchange rate regimes correlates with lower productivity growth. Our findings in Chapter 3 show that the acquisition of capital imports enhances economic growth and lessens relative income differences. However, countries that invest relatively more in domestic capital experience a faster relative income growth with respect to the Unites States. In Chapter 4, we document the existence of an inflation threshold located at a 14% inflation rate. Inflation lower than the threshold is found to be significantly conducive to economic growth. In contrast, additional inflation higher than the threshold has a detrimental effect on economic activity.

"Praise the Lord, all you nations;
extol him, all you peoples.
For great is his love toward us,
and the faithfulness of the Lord endures forever.
Praise the Lord." (*Psalm 117 NIV*).

Table of Contents

List of Tables

List of Figures

Acknowledgements

Thanks to God the Father, Jesus Christ and the Holy Spirit for giving me the health, knowledge and wisdom to complete my doctoral studies

This thesis is dedicated to my parents Yvonne Féliz and Ramon Lagares for their unconditional support, guidance and motivation.

I am extremely grateful to my supervisors Gulcin Ozkan and Michael R. Wickens for their invaluable revisions and comments to this thesis, as well as for their constant guidance during my studies.

A special gratitude is for professors Peter N. Smith, Costas Millas, Neil Rankin, Karen Mumford and Paulo Santos Monteiro, as well as to Ms. Jo Hall for their helpful advices.

I gratefully acknowledge the financial support provided by the Department of Economics and Related Studies of the University of York and the Central Bank of the Dominican Republic.

This thesis has greatly benefited from helpful comments and suggestions from an anonymous referee, and seminar participants at the Macroeconomics & Finance research cluster group of the University of York, the White Rose Doctoral Training Centre in Economics, and the Royal Economic Society conferences. Their important comments and suggestions are greatly appreciated.

Author's Declaration

I hereby declare that this doctoral thesis is solely the result of my own original work, research and contribution to the degree of Doctor of Philosophy in Economics at the University of York.

I also certify that this thesis has not been previously presented or submitted for examination at this or any other educational institution. Due acknowledgments have been made in the text and the references to any other third party content cited in this thesis. The views presented in this thesis are the sole responsibility of the author.

Chapter 1

Introduction

This introductory chapter starts with a survey of the economic history of the Latin American economies from the colonial period until the first decade of the twenty-first century. We then proceed to discuss current issues and gaps in the existing literature on economic growth and development in these economies during the last fifty years. Finally, we present the main contributions of this thesis, and the outline for the rest of our research.

The colonial institutions established in Latin America have had dramatic consequences for the region's long term economic growth and development performance (Acemoglu et al., 2001). Among the historical legacies of the colonization was a weak institutional environment characterized by a lack of protection of property rights and a limited rule of law (Maddison, 2001). These factors were not conducive for domestic innovation and research in new technologies. In addition, the colonization was oriented towards the extraction of resources from the colonies, and the promotion of international trade through a complex institutional arrangement that did not favour the development of internal markets in these economies (Franko, 2007). The established pattern of international trade in Latin America was characterized by the colonies specializing in the production and exportation of agricultural primary products in exchange of manufactured goods and capital proceeding from the developed economies.

The export-led growth of the colonization was not successful in enriching the population in Latin America. Despite that annual GDP per capita grew approximately 0.19% on average from 1600 to 1820—higher than in Western Europe where average growth was nearly 0.15%—the distribution of income was severely biased in favour of the Iberian immigrants established in the region rather than benefiting the local indigenous class (Maddison, 2001). The local communities of Latin America were largely deprived of access to land and education, which seriously hampered labour productivity and human capital thus contributing to the major differences in per capita income growth. The institutional arrangements and the social structure of the colonization—in terms of the limited rule of law and the lack of protection of property rights—were against the lower income class and in favour of the upper income groups and the aristocracy. These institutional features of the colonization persisted long after the independence of the Latin American countries (Acemoglu et al., 2001).

International income levels in Latin America declined sharply during the colonial period in relation to those that prevailed in the Unites States. The income levels of Latin America dropped substantially from nearly a half of the U.S. income at the start of the eighteenth century, to approximately a quarter of the industrial leader income by the end of the nineteenth century (Parente and Prescott, 2005)[1]. The export-led growth of the Latin American economies was eventually disrupted during the First World War and the Great Depression of 1929. During those years dramatic changes started to occur to the patterns of international trade in the world economy. The collapse of export prices, the slow growth of international trade, the limited income elasticity of demand for agricultural primary products in the

[1] The end of the nineteenth century marks the start of modern economic growth in Latin America (Parente and Prescott, 2005). This latter period also coincides with the industrial revolution occurring in the advanced economies, and the spread of technological progress to Latin America. The relatively more efficient use of resources in these economies, alongside with the various institutional reforms implemented during the independence, dismounted many institutional constraints of the colonization such as slavery, the Caste system, and many other privileges and exemptions which favoured the elite, thus improving labour mobility and productivity, thereby increasing economic growth (Furtado, 1976, Coatsworth, 2008).

advanced economies, and the declines in the terms of trade, severely restricted the growth capacity of the Latin American countries (Bulmer-Thomas, 2003).

The Prebisch-Singer theory of economic development predicted the decay and the uneven development of Latin America. According to Singer (1950), the production process of primary commodities in the export sector of the underdeveloped countries is characterized by a high content of imported capital, foreign technologies and intermediate inputs of production. As a result, by specializing in the production and exportation of raw materials and agricultural primary products, these economies do not have enough incentives to invest in domestic innovation and research in new technologies. This is one of the main reasons for their low productivity growth, as the productivity and technology employed in the export sector is not transferred to other production sectors of the economy.

The use of foreign inputs, capital and foreign technology in the export sector limits domestic innovation in new technologies, and leads to technological disparities with respect to the other production sectors of the economy[2]. In that order, there were limited investments and insufficient capital accumulation occurring in the neglected sectors of the economy, as resources were primarily devoted to the export industry. Moreover, the decline in the terms of trade—the rise of import prices against export prices—further limited the acquisition of foreign capital and technology in the underdeveloped countries. As a result, productivity and capital accumulation were limited in these economies thereby leading to the observed differences in per capita income levels.

A centre-periphery analysis where disparities in the spread of technology leads to differences in per capita income levels in Latin America is developed by Prebisch (1950, 1959). According to this dependency theory, the underdeveloped or peripheral countries of Latin America critically depend on foreign technology and imported capital proceeding from the industrialized countries or the centres. This dependency originates from the specialization of

[2] The underdeveloped economies are dualistic in nature as technological disparities exists between the export sector and the other production sectors of the economy. In that order, the export sector may have a higher technological capability than other production sectors of the economy characterized by technological backwardness (Singer, 1950).

the periphery in the production and exportation of primary commodities and raw materials. The periphery does not largely produce high-end manufactured goods, services and capital, nor invest sufficiently in domestic innovation and research in new technologies, and therefore must rely on foreign capital and technology proceeding from the centres. On the contrary, technological progress and productivity improve continuously at the centres, which invest heavily in the research and development of new technologies—as well as capital accumulation—as they specialize in the production of high-end manufactured goods and capital.

The periphery devotes most of its resources to the export sector. As a result, the other production sectors of the economy are deprived of sufficient investment and capital accumulation, consequently the limited productivity growth in these economies. Not only is the diffusion of technology unevenly distributed from the centre to the periphery, but in addition there are technological disparities across the different production sectors of the economy in the periphery[3]. For these reasons, there is a limited technological progress and productivity in the economy of the periphery which in turn restricts economic growth and leads to per capita income differences and uneven development.

The declines in the terms of trade further aggravate the uneven development of the periphery. In the context of the limited international demand for raw materials and primary products of the periphery, the increase in the import prices of manufactured goods and capital limits the adoption of new capital and technologies in the periphery thereby restricting the prospects of economic growth and development. The proposed solution for Latin America was to promote inward development by import substitution industrialization. Improving the institutions, investing in the research and development of new technologies, in physical and human capital accumulation, and investing in the infrastructure and development of the internal markets were seen as key factors for the industrialization and the long term economic growth and development of Latin America (Franko, 2007).

---

[3] Rather than focusing on the controversial hypothesis of the declines in the terms of trade, we focus particularly in the technological disparities hypothesis of the Prebisch-Singer theory. For an extended discussion on the Prebisch-Singer theory for Latin America see the works of Baer (1962) and Frankenhoff (1962).

At the start of the second half of the twentieth century, the governments of the region implemented several economic policy programs to drive the necessary industrialization. As a result, the economic growth and development performance of the region has varied considerably over the last fifty years. At the start of the 1950's, various import substitution industrialization (ISI) policies started to be implemented across most of the Latin American economies. Initially, the principal objective of the ISI programs was to use economic policy to encourage the domestic production of the manufactured goods that were being imported from abroad (Baer, 1972, 1984).

At an initial stage of the industrialization process the ISI programs encouraged the importation of key capital goods and industrial intermediate inputs of production that were necessary to consolidate the domestic production of the manufactured products. At a later stage of the industrialization process—once the domestic industries have been developed—the programs were expected to consolidate the vertical integration of the production process. In that order, the final aim of the industrialization was also to substitute the importation of the key capital goods and intermediate inputs of production that were being imported. However, this later stage of industrialization process have not occurred to a large extent in Latin America, and the dependency to imported capital and the foreign technology continued during the import substitution industrialization period.

Among the primary economic policy tools of the ISI programs that were implemented in Latin America stand out the use of the exchange rate as the main economic policy tool to drive inward development. In order to develop the infant industries of the region, an economic policy of overvalued and preferential exchange rates were implemented to facilitate the initial importation and acquisition of the key capital goods and intermediate inputs of production for the infant industries that the governments sought as important for the industrialization project. In addition, import restrictions and quotas were implemented to discourage the unnecessary imports of final goods and services (Baer, 1972). The governments heavily financed the creation of state owned monopolies in key industries such as mining, telecommunication and energy. In addition, the governments also heavily financed a vast spectrum of infrastructure projects such as the creation of railways, maritime ports, airports, highways, and in many cases vast housing projects for the increasing urban population (Franko, 2007).

The import substitution industrialization policies were somewhat successful in boosting initially economic growth and preventing the downward trend of relative income levels. In Latin America the average annual cumulative growth rates of the total gross domestic product from 1950-60 and 1960-70 were 4.7% and 4.5% respectively (Baer, 1972). In addition, during this period, the international income levels of the region improved slightly relative to those of the United States (Parente and Prescott, 2005). However, despite the initial success in per capita income growth, the ISI policies created several economic imbalances in the region that at the end started to inhibit economic growth. In what follows, we focus on the aspects that in our view are the most important of the import substitution industrialization policies.

The production of raw materials and agricultural products was sought to be a feature of the colonial period, and the reason for backwardness. In that order, during ISI the agricultural sector along with the necessary land reforms to increase agricultural productivity continued to be neglected in Latin America. The use of overvalued and preferential exchange rates restricted the growth capacity of the export sector, and in addition discouraged the production and exportation agricultural primary products. As production in the agricultural sector declined, labour migrated from the rural areas to the urban centres. The massive immigration to the urban areas added stress to the infrastructures of the cities, and was a factor contributing to the rising prices of food and other primary products. In addition, inequality also increased in the urban centres due to the rising unemployment caused primarily by the lack of labour absorption of the capital-intensive manufacturing industries[4]. Furthermore, the governments funded inefficient state owned enterprises, as well as unproductive investments and consumption expenditures. As the main sources of government funding were the inflation tax, the use of domestic and external debt along with foreign

[4] The use of overvalued and preferential exchange rate to acquire new imported capital and intermediate inputs of production lowered the relative price of capital and encouraged the implementation of capital intensive production processes.

capital, the fiscal accounts and the balance of payments started to deteriorate[5].

The several economic imbalances created by the indiscriminate way in which ISI was implemented led to the gradual abandonment of these policies during the late 1960's and the 1970's. However two important issues were of considerable importance in Latin America. The first was the general and in many instances persistent increase in inflation. The second was the declines in the growth rates of per capita income (Furtado, 1965). Nevertheless, economic growth in Latin America was moderate despite the several economic imbalances created by the import substitution industrialization policies. However, output growth started to deteriorate after the shock to oil prices in 1973. The oil prices shock fuelled inflation globally and many industrialized economies started to implement a restricted monetary policy. The restricted monetary policy adopted by most advanced economies led to increases in the real interest rate at the world capital markets, and consequently the availability of foreign capital to the periphery was limited thus further restricting investments in these economies.

In Latin America the export prices and the terms of trade deteriorated during the second half of the 1970's. The rise in import prices limited the importation of capital goods and intermediate inputs of production. As a result, economic growth in the region started to decelerate. The neglect of agriculture and the export sector continued to fuel unemployment and income inequality. Given the deterioration of the fiscal revenues and taxes, the governments relied on the inflation tax, domestic and external debt to continue funding the investment programs. By the end of the 1970's the economic situation was unsustainable in Latin America, and the debt crisis started in the early years of the 1980's. This latter period is commonly referred to as "the lost decade" (Kaminsky and Pereira, 1996).

In the light of these unfortunate sequence of events, during the 1980's and the 1990's the Latin American economies began a series of economic reforms in order to change the course of economic policy and the structure of the economy. A more market oriented approach was adopted, and a return to

---

[5] For a survey on import substitution industrialization policies and its consequences for economic growth and development in Latin America see Hirschman (1968), Baer (1972, 1984), Cardoso and Fishlow (1992), and Taylor (1998).

outward development was generally viewed as the best option (Williamson, 1990). Among the various economic reforms implemented in the region were the dismantling of protection for the domestic industries, and the adoption of liberal trade policies. In addition, several trade agreements were signed to secure the preferential access of Latin American exports to the advanced economies. Various land reforms and loans at preferential interest rates were given to the neglected export sector, principally that of the production and exportation of agricultural primary products and raw materials. In that order, investments in the export sector increased, and consequently production and productivity resumed in the export industry.

Various institutional reforms were also implemented, and the rule of law and the protection of property rights was strengthened. The governments stabilized the fiscal accounts by improving the tax system and curtailing inefficient subsidies to unproductive state owned enterprises. The state owned monopolies were dismantled and various state owned enterprises privatized thus promoting a more competitive market. The governments of the region also created state-owned banks capable of providing credit at preferential interest rate to entrepreneurs as well as to small and medium enterprises. The price restrictions that were initially imposed in an attempt to control inflation were also dismounted thus reducing price distortions in the economy.

A monetary policy characterized by flexible exchange rate regimes, competitive currency depreciations and undervaluations was adopted to discourage the unnecessary importation of final goods and services. These exchange rate policies favoured the export sector and foreign direct investments thus improving the balance of payments. A counter-cyclical monetary and fiscal policy was implemented to reduce inflation and promote macroeconomic stability. These reforms strengthened and improved the fiscal accounts, the financial system and central bank independence[6].

Several macroeconomic crises occurred in Latin America during the periods of economic reforms, as the market adjusted to the new changes in

---

[6] For additional discussion on the economic reforms implemented in Latin America and their impact on economic growth and development see Williamson (1990), Bresser-Pereira (1993), Naím (1994), Edwards (1995), Baer and Maloney (1997), Easterly et al. (1997), Morley et al. (1999), Lora (2001), Lora and Panizza (2002).

economic policy (Edwards, 1995). Since the late 1990's and during the first decade of the twenty-first century, economic growth resumed in the region, and per capita income levels improved slightly until the recent global financial crisis that started in 2008 (Robinson, 2004, Ocampo, 2009).

Despite the various economic reforms implemented in Latin America and the adoption of outward oriented policies, the evolution of international income levels in the region has been historically uneven, and in the last fifty years little progress have been made in terms of sustainable economic growth and development. Latin America has maintained a fairly constant gap in terms of relative income levels with respect to the United States as industrial leader. On average, the international income levels of Latin America have remained at approximately a quarter of the United States income in the last hundred years (Parente and Prescott, 2005).

The examination of the economic history of Latin America presented in this introductory chapter suggests that historically the disparities in the international levels of per capita income and the rate of technological progress have led to uneven development not only between the economies of the region, but also in relation to the United States as industry leader. The persistent differences in economic development, technological change and growth appear to be largely attributable to differences in institutions and economic policy rather than to differences in factor endowments and geographic characteristics[7].

The existing literature often suggests institutions as the most important factor explaining economic growth and development (Rodrik et al., 2004)[8]. For example, Acemoglu et al. (2003) shows that countries that inherited extractive institutions from their colonial period were more likely to implement poor macroeconomic policies that leads to macroeconomic

---

[7] For example, Dominican Republic and Haiti share the same island in the Caribbean region; however, while the former is considered by the World Bank as an upper middle income economy, the latter is the poorest country in the Americas. Surprisingly, over the period from 1970 to 2010, the average per capita income of Brazil—the largest economy in Latin America—is approximately 21% relative to that of the United States. On the contrary, The Bahamas and Trinidad and Tobago—two relatively small Caribbean economies—are among the richest in the region with an average per capita income relative to the United States of nearly 77% and 52%, respectively, according to data proceeding from the Penn World Tables (cgdp series, version 7.1).

[8] See also the works of North (1989, 1991, 1994).

instability and crisis, thus leading to a limited economic growth and development. Once controlling for institutions, the potential role of economic policy and endowments appears to be limited (Easterly and Levine, 2003). However, there is disagreement on the extent that institutions alone may explain differences in economic performance over time, particularly in the developing economies of Latin America (Engerman and Sokoloff, 2000, Engerman, 2003, Coatsworth, 2005, Engerman and Sokoloff, 2005). Macroeconomic policy has also been suggested to be an important diver of long run economic growth and development, as these policies may have important effects on resources allocation and investment decisions thus affecting capital accumulation, productivity and technological progress (Fischer, 1991, 1993). By implementing the necessary institutional and economic policy reforms, developing countries may grow faster and converge towards the advanced economies per capita income levels.

In our view, three issues of fundamental importance have not been comprehensively examined in the study of economic growth and development in Latin America. The first issue relates to the role of real exchange rate variations, currency misalignments and nominal exchange rate regimes in explaining productivity growth, and consequently economic growth and development. Exchange rates has been widely used as a key economic policy instrument to drive both import substitution industrialization and outward development in the region (Franko, 2007)[9]. An economic policy of overvalued and preferential exchange rates along with fixed exchange rate arrangements was implemented during the period of import substitution industrialization in order to encourage the importation of key intermediate inputs of production and capital goods for the infant industries (Baer, 1984). These policies were gradually reverted during the late 1970's, and the renewed outward development approach of the 1980's and 1990's, where the Latin American economies started the transition towards more flexible exchange rate arrangements, competitive currency depreciations, and currency undervaluations in order to stabilize the balance of payments and promote outward development via the export sector (Frenkel and Rapetti, 2010).

[9] To simplify the discussion in this introduction, in what follows, we use the general term exchange rates to refer indistinctively to both nominal and real exchange rate variations, exchange rate misalignments, and exchange rate regimes. In addition, we use the term depreciation and devaluation interchangeably.

Conventionally, an economic policy of flexible exchange rates, competitive currency depreciations and undervaluations has been generally viewed as appropriate for developing countries in order to promote economic growth and development (Bhalla, 2008, Rodrik, 2008, Razmi et al., 2012). However, there has been a growing disagreement in the existing literature with respect to the growth and development benefits of these exchange rate policies. In an important study about the relationship between exchange rates and economic development, Ito et al. (1999) suggest that a sustainable economic growth and development is incompatible with persistent currency depreciations and misalignments. In addition, currency misalignments have often been found to have distortionary effects on output growth, while exchange rate stability is frequently viewed as the appropriate exchange rate policy for the less developed countries (Edwards, 1989, Cottani et al., 1990, Pick and Vollrath, 1994, Toulaboe, 2006, Eichengreen, 2008).

Flexible exchange rate arrangements appear more conducive to economic growth in financially developed high income countries. On the contrary, intermediate and fixed exchange rate regimes often correlate with lower inflation, higher regime durability and output growth in developing countries (Husain et al., 2005). For example, Krugman and Taylor (1978) have shown that from an initial trade deficit currency devaluations have a contractionary effect on output growth in developing countries. A similar view is also shared by Agénor (1991) where in a rational expectations model currency devaluations are found to have a detrimental effect on economic growth.

The debate on the role of exchange rates on productivity, economic growth and development in Latin America has received less attention in the existing literature. The general consensus is that flexible exchange rate regimes, competitive currency depreciations and undervaluations will be the best strategy to promote economic growth and development (Gala, 2008). What has been disregarded in existing studies of exchange rates and economic growth in Latin America are the potential growth effects of exchange rates variations, misalignments and exchange rate regimes operating through the channels of productivity, given the dependency of these economies to imported capital and foreign technologies.

The second issue of fundamental importance that have not been thoroughly examined in Latin America relates to the continuous dependency of the these economies to imported capital and foreign technology, which leads to technological disparities resulting in per capita income differences as initially proposed by Prebisch (1950, 1959) and Singer (1950). Total factor productivity growth rather than capital accumulation has often been suggested to the main driver of growth and development in the region[10]. However, the disagreement in the existing literature starts with respect to the sources of this total factor productivity growth (Romer, 1994). If imported capital contains embodied foreign technologies, then the acquisition and accumulation of imported capital and machinery equipment may drive productivity growth, thereby enhancing long run economic growth and development (De Long and Summers, 1991, 1993). The idea of embodied technological change in capital is currently under dispute in the existing literature, and is commonly referred to as the embodiment controversy (Hercowitz, 1998).

In an earlier analysis of productivity growth in Latin America, Bruton (1967) shows that productivity growth in the region is primarily achieved by physical capital accumulation and using excess capacity rather than by innovation and research in new technologies. Bruton (1967) primarily attributes this lack of domestic innovation and research to the lack of incentives of entrepreneurs and firms to change a production process in these economies which crucially depends on importing intermediate inputs of production and foreign capital. In addition, Paus et al. (2003) and Paus (2004) have also shown that imported capital is a plausible channel explaining productivity growth in Latin America. Moreover, in terms of the production process of the export goods, Hummels et al. (2001) examined ten OECD economies and four emerging market economies from 1970 to 1990, and documents the increasing use of imported inputs in the production process of the goods that are exported.. They refer to this important change in the patterns of international trade as vertical specialization.

The role of imported capital has not escaped unnoticed in the endogenous growth literature. In an important contribution, Lee (1995) propose an open economy endogenous growth model where by acquiring imported capital in the form of machinery equipment, and increasing the ratio of capital imports

[10] For a discussion see De Gregorio and Lee (1999), Solimano and Soto (2005), Daude and Fernández-Arias (2010).

in investments, the economy experiences a faster rate of per capita income growth. The conclusions of the model are tested empirically in a sample eighty-nine advanced and developing countries from 1960 to 1985. Their results show that restrictions to the acquisition and accumulation of imported capital inhibit per capita income growth in developing countries. This model is further examined and extended by Mazumdar (2001) to account for differences in both imported and domestic equipment capital. Their findings suggest that while imported equipment drives faster growth, the role of domestic capital is statistically insignificant in the growth process of the less developed countries.

The view that the accumulation of imported physical capital may drive faster economic growth appears in conflict with the neoclassical theory of economic growth, where growth is primarily driven by exogenous technological change. However, if the source of productivity are endogenous, then other factors such as capital accumulation, innovation and research, the efficient use of technology, economic policy and institutions may also play a crucial role on productivity (Parente and Prescott, 2005, Crespi and Zuniga, 2012). These issues have not been specifically examined before for the Latin American countries. Despite the historical dependency of these economies to imported capital and foreign technology, as well as the influence of this imported capital on productivity, to the best of our knowledge very few studies have been undertaken to examine how domestic and imported capital affects economic growth and development in Latin America. Where these studies have taken place they only examined a handful of countries in the region, and most of them conclude that exogenous total factor productivity growth rather than capital accumulation is the main driver of growth and development in the region (Daude and Fernández-Arias, 2010).

Finally, the third issue of fundamental importance that has not been comprehensively examined in Latin America is the exact nature of the growth effects of inflation at low and moderate inflation rates. Latin America provides cases of stagnation with low inflation and price stability, as well as cases of output growth with moderate and high inflation. It has been a controversy what is the exact role of inflation on economic growth and development in Latin America (Baer, 1967). This issue has been at the centre of the debate between the structuralists and monetarist schools of economic development in the region.

The structuralists claim that inflation is the result of structural and socioeconomic rigidities in the Latin American economies. The growing demand for food in the urban centres, given an inelastic supply for agricultural products, fuel inflation. In addition, the declines in the terms of trade increases the domestic prices of the imported goods and services whose demand is relatively inelastic. Moreover, the expansionary fiscal policy needed to drive inward development through investments in infrastructures and state-owned enterprise that may support the infant industries also appears to be a driving force in the inflationary spiral. In that order, inflation was seen by the structuralists as initially necessary at an earlier stage of the development process until the economy was able to industrialize, and some of these structural and socioeconomic rigidities were addressed. At a later stage of development, a sustainable economic growth was expected to resume with price stability.

On the other side of the debate were the monetarists who viewed inflation as being the result of uncontrolled increases in the money supply, balance of payments difficulties, and the monetization of the fiscal deficit through seigniorage revenue and massive amounts of debt in order to finance unproductive government investments, consumption expenditures and unproductive state owned monopolies. The monetarists viewed inflation as distorting the appropriate allocation of resources thus inhibiting short-term to medium-term economic growth. Since in their view money and hence prices were uncorrelated with long-run economic growth and development—as opposed to the structuralists who viewed inflation as initially necessary to drive inward development—economic policy should be aimed to curtail inflation at all costs. Despite the initial growth slowdown that will bring price stability, once the distortions caused by inflation have been addressed, a sustainable economic growth and development will resume[11]. The monetarists will sacrifice output growth to attain price stability. On the contrary, the

[11] For additional discussion on the structuralist and the monetarist view of inflation in Latin America see Seers (1962), Baer (1967), Fischer and Mayer (1980), Baer (1984) and Boianovsky (2012).

structuralists will cope with rising prices provided that output growth take-off in the Latin American economies.

The evidence for Latin America has been overwhelmingly against any form of inflation in the region. In an important study of the growth process in the region, De Gregorio (1992a) finds that inflation is negatively correlated with output growth at all inflation levels, however acknowledge the possibility of nonlinearities in the inflation-growth relationship. In two further studies about the relationship between inflation and economic growth in the region, De Gregorio (1992b, 1993) concludes that inflation may have a negative effect on long-run economic growth in the region through its distortionary effects in the productive allocation of resources, and the accumulation and productivity of capital. A more recent study on these issues is that conducted by Bittencourt (2012) where by examining four Latin American economies from 1970 to 2007 their results show that inflation has a clear detrimental impact on economic growth.

The view that inflation have a negative effect on output growth across all inflation levels appears to be the consensus nowadays in the existing literature[12]. However an important question relates to the level of inflation at which rising prices starts to distort economic activity. It seems to be the case that the growth effects of inflation may vary according to the inflation rate. Among the first to study nonlinearities and threshold effects in the inflation-growth relationship is Fischer (1993) who by adopting the spline function approach proposed by Greene (1993) suggests two possible inflation threshold located at approximately a 15% and a 40% inflation rate for a large sample of advance and developing countries from 1961 to 1988. According to Fischer (1993), inflation rates below the threshold have a positive but in many instances insignificant effect on economic growth, while inflation rates exceeding the threshold have a clear negative effect on economic activity. A similar conclusion is reached by Sarel (1996) where by adopting a similar spline function model their results show significant evidence in favour of a structural break in the inflation-growth relationship occurring at a 8% inflation rate in a sample of eighty-seven advanced and developing countries from 1970 to 1990. Sarel (1996) also finds that when nonlinearities and

---

[12] See Wallis (1960), Fischer and Modigliani (1978), Driffill et al. (1990) and Temple (2000).

threshold effects are not accounted for in the examination of the growth effects of inflation, the estimates for these growth effects are biased.

A breakthrough in the modelling of nonlinearities and threshold effects in regression models was a series of papers published by Hansen (1996, 1999, 2000) and Caner and Hansen (2004). These papers presented and discussed the statistical theory for threshold estimation, testing and inference for cross-sectional and panel data models. An important feature of these threshold models is that the threshold was being estimated as a parameter of the model rather than being specified by the researcher in the regression. However these methods had some important limitations that made their application to growth econometrics to be handled with caution. In particular, these methods could not be applied to dynamic panels with endogenous regressors where the endogenous regressor was also a lagged dependent variable. This was the particular case of empirical growth models where initial income is a key growth determinant that by construction is a lagged dependent variable and endogenous regressor.

An important contribution to growth econometrics and threshold estimation was recently made by Kremer et al. (2013). Their model extends the Hansen (1999, 2000) and Caner and Hansen (2004) threshold estimation methodology to dynamic panels with endogenous regressors and a lagged dependent variable. Kremer et al. (2013) applied their new dynamic panel threshold model to examine nonlinearities and threshold effects in the inflation growth nexus of a hundred and twenty-four advanced and developing economies from 1950 to 2004. Their findings show evidence in favour of a statistically significant inflation threshold occurring at a 2.5% and 17.2% inflation rate for advanced and developing countries respectively. Their results also suggest that inflation below the threshold has a positive but statistically insignificant effect on output growth, while inflation rates exceeding the threshold have a detrimental effect on economic activity.

The examination of nonlinearities and threshold effects in the inflation-growth nexus using this novel dynamic panel threshold model has not been specifically applied to the Latin American economies. To the best of our knowledge, neither have been investigated the role of nonlinearities and threshold effects between inflation and economic growth in the context of the structuralist and the monetarist approach to economic growth and development in the region.

This thesis examines the economic growth and development process of the Latin American economies in the last fifty years from 1960 to 2010. Due to the importance of exchange rates in driving historically export-led growth and inward development, our research starts by focusing on the growth effects of exchange rate variations, currency misalignments and exchange rate regimes on driving productivity growth. We then proceed to examine the growth effects of domestic and imported capital on economic growth and relative income differences. Finally we examined nonlinearities and threshold effects between inflation and economic growth in Latin America. These are issues of considerable importance that have not been previously examined in the existing literature on economic growth and development in Latin America, and we intend to cover these important gaps in the literature with the research presented in this thesis.

One of the novelties of our approach, unlike previous studies, is the examination of these issues within the context of the Prebisch (1950, 1959) and Singer (1950) technological disparities hypothesis which essentially ascribe uneven development in Latin America to disparities in the process of technology diffusion. These technological disparities are viewed as mainly proceeding from the continuous dependency of these countries to imported capital, which limits domestic innovation and research in new technologies, and domestic capital accumulation, with the corresponding consequences for economic growth and development. Also affecting growth and development in the region is the inflationary performance of these economies which is closely related to the dependency to imported capital and foreign technologies, along with other structural and socioeconomic rigidities present in these economies. We examine all these issues in the present thesis, and in subsequent chapters we provide a coherent framework and economic meaningful connection through all these themes.

The main contributions of this thesis to the study of economic growth and development in Latin America are as follow. In Chapter 2 we examine the growth effects of real exchange rate variations, currency misalignments and exchange rate regimes on productivity growth for thirty-two Latin American economies over the period from 1980 to 2009. We compile a new macroeconomic dataset for all the economies classified in the Latin American region according to the International Monetary Fund classification. To the best of our knowledge, this is the first thesis to study exchange rates and productivity growth in the vast majority of the Latin American economies.

The main contributions of Chapter 2 to the study of economic growth and development in Latin America are summarized as follow: First we find that real exchange rate depreciations decreases productivity growth in Latin America. In other words, there is a contractionary effect of real exchange rate depreciation on productivity. Second, we find that real exchange rate volatility lessens productivity growth. Third, currency misalignments are found to correlate with lower productivity, however the growth effects of currency misalignments are found to be statistically insignificant. Fourth, we find evidence on the neutrality of nominal exchange rate regimes in explaining productivity variations. Nevertheless, flexible exchange rate regimes correlate with lower productivity, in particular if flexibility results in a trend towards currency depreciations.

The dependency of these economies to imported capital and foreign technologies is suggested to be a plausible channel through which the contractionary real exchange rate effects on productivity may operate. By increasing the acquisition and investments costs of key imported intermediate inputs of production and capital goods, currency depreciations may limit the availability of imported capital with embodied technologies thereby decreasing productivity. Overall, our results show that exchange rate stability is conducive to productivity, economic growth and development in Latin America.

In Chapter 3 we examine the growth effects of domestic and imported capital on economic growth and relative income differences in the Latin American economies over the period spanning from 1960 to 2010. Our selection of countries can be considered one of the largest ever used in the existing literature to study economic growth and development performance in the region. In this third chapter we present the compilation of a new and extended macroeconomic panel dataset for all the Latin American economies during the selected time period with more than ten growth determinants which includes disaggregated data on capital imports, domestic human and physical capital, economic policy indicators, as well as other economic aggregates, thus improving and extending the study of economic growth to the vast majority of the small and developing economies in the region.

Our aim in this third chapter is to uncover new evidence in order to provide answers to key old questions related to the role of capital accumulation on growth and development in the region. Primarily, these questions are concerned to whether capital imports with embodied technologies are the most significant drivers of economic growth and relative income levels in Latin America? Have domestic physical and human capital played a major role in explaining the region's growth performance? Does capital accumulation explain the variety of growth experiences that we observe across different income levels? Is there a dependency of the growth process to capital imports of the type suggested by the Prebisch-Singer theory?

The main contributions of Chapter 3 are as follows. First, countries in Latin America are able to grow faster by acquiring capital imports in the form of machinery equipment. Our findings indicate that not only machinery investments drive faster economic growth, but also that once endogenous interactions have been accounted for, the growth effects of domestic capital are insignificantly lower than those provided by machinery imports. There is a positive correlation between higher productivity growth rates and the acquisition of machinery imports in Latin America.

Second, countries that invest relatively more on domestic capital reduce faster their relative income differences. In other words, relative income to the Unites States grows faster in countries that invest relatively more on domestic equipment and non-equipment capital. Therefore, there is a significant role for domestic capital in reducing cross-country relative income differences in Latin America as initially suggested by the Prebisch-Singer theory. While capital imports drives faster economic growth, domestic capital is a key determinant of higher relative income levels, therefore both sources of capital are needed to drive economic development towards advanced economies living standards.

Third, human capital appears to have an insignificant effect in the growth process of the Latin American economies. Fourth, our results indicate that countries which experienced a slowdown in economic growth rates where relatively richer in 1970, adopted less machinery imports, and did not invested enough in domestic capital. Fifth, the diversity of growth experiences observed across different income levels in Latin America suggests that economic policy, endowments, trade patterns and the level of institutional development have played a determinant role in the growth and development process of these economies.

Finally, in Chapter 4 we examine nonlinearities and threshold effects in the inflation-growth nexus in Latin America from 1960 to 2010. In addition, unlike previous studies, a novelty in our approach is that we also examine the role of fiscal policy in the determination of inflation thresholds in the region[13]. The main contributions of this fourth chapter to the study of economic growth and development in Latin America are as follow. First, we document the existence of an inflation-growth nexus in Latin America as predicted by the structuralist view of inflation in the region. Second, we find statistically significant evidence in favour of nonlinearities and threshold effects in the inflation growth relationship. The growth effects of inflation are unequal across varying inflation rates. Third, our results show evidence of an inflation threshold located approximately at a 14% inflation rate in Latin America. Fourth, inflation lower than the threshold is found to have a statistically significant positive effect on economic growth. Fifth, inflation higher than the threshold has a strong detrimental effect on economic activity.

Sixth, while controlling for high inflation observations, our findings suggest that low inflation countries may have a lower inflation threshold than high inflation countries. Seventh, accounting for fiscal policy and the money supply does not change the qualitative results of this chapter. Eight, our findings support the structuralist view of inflation and long-run economic growth and development in Latin America. Ninth, while initially we do not find significant evidence in favour of cross-sectional correlation amid inflation and output growth, our findings suggests that once controlling for fiscal policy there is a correlation between inflation and economic activity in a cross-sectional setting. Tenth, once accounting for the rate of investment, increases in the money supply, fiscal policy, financial development and macroeconomic crisis, our evidence suggest the productivity of capital as one of the main

[13] To the best of our knowledge, we are the firsts to examine the role of fiscal policy in the determination of nonlinearities and threshold effects in the inflation-growth nexus of the Latin American economies.

plausible channels through which the growth effects of inflation may operate in Latin America.

A variety of different robustness checks are implemented to reaffirm the validity of the main contributions presented in this thesis. We find that our results are robust to different econometric methods, additional explanatory variables, outlier's sensitivity, variations in the number of countries and time periods under examination. In addition, the empirical application of our models also accounts for potential unobserved heterogeneity, cross-sectional dependence, the possible endogeneity of the growth determinants, as well as alternative specifications and non-linear hypothesis. The time span of the data and the selection of countries were largely determined by data availability of the Latin American countries.

The rest of the thesis is organized as follow. Chapter 2 examines the role of real exchange rate variations, currency misalignments, and exchange rate regimes on productivity growth. Chapter 3 examines capital, economic growth and relative income differences. Chapter 4 examines inflation threshold and economic growth. Chapter 5 provides the conclusions, main economic policy recommendations, and a discussion on the agenda for future research. A further description of some of the methods implemented in this thesis, along with the list of countries and additional robustness checks are provided in the appendices.

Chapter 2

Exchange rates and productivity in Latin America

2.1 Introduction

The colonial institutions established in Latin America have had important consequences for productivity growth and economic development in Latin America. Historically, among these consequences is a weak institutional environment that is not conducive for domestic innovation and research in new technologies. Therefore, the growth process in these economies relies heavily on imported capital and foreign technologies[14].

The Prebisch-Singer theory predicted the relative decay and stagnation of economic development in Latin America (Prebisch, 1950, Singer, 1950, Prebisch, 1959). According to this theory, one of the main causes for the underdevelopment of Latin America is the high dependency of these economies to imported capital and foreign technologies which leads to

[14] There is a robust nexus between institutions, economic growth and development, particularly in developing countries. Lower levels of institutional development appear to correlate with poor macroeconomic performance and limited productivity innovations (North, 1989, 1991, Acemoglu et al., 2001).

technological disparities and uneven development. In an early study about productivity growth in the region, Bruton (1967) shows that these countries are characterized by a capital intensive production process that relies heavily on imported capital. As a consequence, productivity growth is primarily achieved by factor inputs reallocation, replacing existing capital, and increasing excess capacity rather than by domestic innovation and research in new technologies. In that order, various studies have documented that economic growth, relative income levels, and productivity have generally decrease in many of these economies since the late 1970's[15]. For these reasons, Latin America has maintained a fairly constant gap in terms of relative income levels with respect to the United States as industrial lealer (Parente and Prescott, 2005).

The proposed solution to drive growth and development in the region was the implementation of import substitution industrialization (ISI) via inward development. Among the primary economic policy instruments of the ISI strategy, real exchange rate depreciations were primarily used to discourage the unnecessary importation of final goods and services, thereby promoting their domestic production. However, preferential exchange rates were also implemented to incentive the importation of key capital goods and intermediate inputs of production for the infant industries seen by the government as important for the industrialization project. In that order, the ISI policies did not completely removed the dependency to imports in these economies[16].

During the export-led growth of the nineteen century and the mid-twentieth century import substitution industrialization policies, currency misalignments and competitive currency depreciations were widely used to promote exports competitiveness and discourage the unnecessary importation of final goods and services. The use of these policies persisted throughout the renewed outward development approach of the 1980's, and the neoliberal reforms of the 1990's. However, the disappointing evolution of productivity growth during these periods cast doubts on the long term growth benefits of these exchange rate policies. Recent studies have suggested imported capital

[15] See Furtado (1965), Arida (1986), Solimano and Soto (2005), Daude and Fernández-Arias (2010).

[16] For a discussion on these issues see Baer (1972).

as a plausible channel explaining productivity growth in Latin America, while currency depreciations and flexible exchange rate regimes have often been found to drive slow growth and poor macroeconomic performance in developing countries (Paus et al., 2003, Kandil, 2004, Paus, 2004, Husain et al., 2005).

A renewed revival in recent years to examine the sources of productivity growth in developing countries have led to an increased interest in the field of exchange rates and productivity. However, few studies have stablished directly that variations in the real exchange rate may drive productivity growth[17]. Too often the theoretical and empirical evidence is controversial, and has focussed on the role of exchange rates on economic growth, with different views held about the implications for the less-developed countries. For example, Rodrik (2008), Gala (2008) and Razmi et al. (2012) favours the view that undervaluation's and competitive currency depreciations may enhance economic growth in developing countries. Couharde and Sallenave (2013) documents a threshold level of currency misalignment, after which undervaluation's are negatively correlated with economic growth. In addition to these studies, Krugman and Taylor (1978) and Agénor (1991) suggests that currency depreciations may actually result in lower output growth in developing countries. Ito et al. (1999) argue that economic development is inconsistent with persistent currency depreciations. Eichengreen (2008) call for exchange rate stability, and Aghion et al. (2009) show that higher exchange rate regime flexibility and real exchange rate volatility drive a lower productivity growth, however the effect crucially depends on the countries levels of financial development.

In the existing literature, the relationship between the real exchange rate and productivity growth have not been specifically examined for the vast majority of the developing and emerging market economies of Latin America. Therefore, in this chapter we are interested in the linkages between exchange rates and productivity growth in these economies. In particular, our main

[17] Traditionally, the evidence suggests that productivity growth drive real exchange rate movements, in particular, currency appreciations (Balassa, 1964, Samuelson, 1964, Froot and Rogoff, 1995, Rogoff, 1996). However, there is also a sparse evidence suggesting that real exchange rate variations, currency misalignments, and exchange rate regimes may have significant effects on improving productivity (Harris, 2001, Aghion et al., 2009).

questions of interest are on whether real exchange rate depreciations, currency misalignments and the adoption of flexible exchange rate regimes may drive slower or higher productivity growth performance in Latin America. In that order, this chapter examines the growth effects of real exchange rate variations, currency misalignments and exchange rate regimes on productivity growth in thirty-two Latin America economies from 1980 to 2009. We compile a new macroeconomic dataset for all the countries classified in the Latin American region according to the International Monetary Fund (IMF) classification. To the best of our knowledge this is the first paper to study the growth effects of exchange rates on productivity growth in the vast majority of the Latin American economies.

The estimation methodology implemented in this chapter utilizes different econometric methods and specifications of the variables. We compile and construct real and nominal exchange rates indexes for each Latin American country. Currency misalignments are constructed following closely the methodologies proposed by Goldfajn and Valdes (1999) and Rodrik (2008). Our measures for exchange rate regimes builds on the extended Reinhart and Rogoff (2004) *natural* classification updated by Ilzetzki et al. (2008), the Levy-Yeyati and Sturzenegger (2005) *de facto* classification, and the IMF *de jure* classification. We control for a wide variety of growth determinants, including Henisz (2012) political constraint index, and a measure for macroeconomic crisis which follows Reinhart and Rogoff (2009), and Laeven and Valencia (2010). Following the econometric methodology proposed by Bond et al. (2001), Roodman (2009a, b) and Aghion et al. (2009), we estimate a dynamic panel productivity growth model using Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) system generalized method of moments estimator with Windmeijer (2005) finite sample corrections, small sample adjustment and collapsed instruments.

Our findings can be summarized as follow: First, we find that real exchange rate depreciations leads to lower productivity growth in Latin America. In other words, there are contractionary effects of real exchange rate variations on productivity. Second, real exchange rate volatility lessen productivity improvements. Third, currency undervaluation are found to be negatively correlated with productivity growth. However, the growth effects of currency misalignments are found to be statistically insignificant. Fourth, our results show that differences in productivity growth are not systematically related to differences in exchange rate regimes. In other words, nominal exchange rate regimes have an insignificant effect on productivity growth. Nevertheless, higher regime flexibility correlates with lower productivity growth, particularly if flexibility results in a trend towards currency depreciations.

Lower levels of institutional development and human capital may reinforce the contractionary effects real exchange rate variations on productivity. A weak institutional environment may limit domestic innovation and research in new technologies, thereby reinforcing the dependency of these economies to imported capital and foreign technologies. Consequently, by increasing the acquisition costs of key capital imports and intermediate inputs of production, real exchange rate depreciations may limit the acquisition of imported capital with its embodied technologies, thereby decreasing productivity. This is an important channel through which the contractionary effects of real exchange rate depreciations may operate. Overall, exchange rate stability is found to be vital for productivity growth and economic development in Latin America.

The rest of this chapter is organized as follow. Section 2.2 discusses the role of the exchange rate policies on economic growth and development in Latin America. Section 2.3 presents evidence on productivity, output and exchange rate dynamics in Latin America. Section 2.4 discusses the methodology and estimation procedure of the productivity growth model. Section 2.5 presents the main empirical findings and robustness checks. Section 2.6 outlines the main conclusions and policy recommendations. Appendices A and B provide further details of the list of countries, the estimation methodology, the definitions and sources of the variables, as well as additional robustness checks.

2.2 Historical legacies of the exchange rate as an economic policy tool for development

The Prebisch-Singer theory ascribe the underdevelopment of Latin America to the uneven spread of technology and the dependency of these economies to imported capital in the context of declining terms of trade (Prebisch, 1950, Singer, 1950, Prebisch, 1959). Influenced by the Prebisch-Singer theory, during the second half of the twentieth century, the Economic Commission for Latin America and the Caribbean (ECLAC) motivated the governments of the region to advocate to a program of imports substitution industrialization (ISI). The primary objective of this program was to create the necessary economic conditions and structures for the domestic production of the goods and services that were being imported from abroad, in addition, to the domestic development of new technologies and higher value manufactured goods and services.

In a comprehensive examination of the import substitution industrialization experiences in Latin America, Baer (1972), and more recently Franko (2007), documented the extensive use of the exchange rate as an economic policy tool to drive inward development. Foreign exchange controls, import quotas and taxes severely restricted and discouraged the importation of final goods and services. On the contrary, at the same time, the ISI policies encouraged the importation of key capital imports, intermediate inputs of production, and specialized machinery via overvalued and preferential exchange rates, special regulations, and fiscal incentives. These policies aimed to acquire the necessary capital and technology in order to develop the key infant industries sought by the government as important for the industrialization project. However, inadvertently, the imports substitution industrialization policies continued to promote the dependency to key capital imports.

During the implementation of the import substitution industrialization policies in the 1960's and 1970's, several Latin American economies experienced a faster rate of economic growth in relation to the pre-ISI period (Baer, 1984). However, by the end of the 1970's, the numerous economic imbalances created by the ISI policies inhibited economic growth. The segmentation of the market, the low income capacity of the population, the high unemployment derived from a limited labour absorption capacity of a capital intensive production process, along with the neglected export sector due to the adoption of overvalued exchange rates, resulted in a weak internal demand for new domestically produced goods and services. In addition, the high production costs and relative prices of these newly produced goods and services further limited their domestic and international demand. In addition, many of these failed to comply with international quality standards.

Due to all these issues, the governments of the region incurred in massive public investment losses by the creation of inefficient industries (Baer, 1972).

At the beginning of the 1980's the massive debts incurred by the Latin American countries in order to promote their industrialization projects were one of the main causes of their debt crisis. The start of the debt crisis in Latin America, and its well-studied causes and consequences, signalled the end of imports substitution industrialization in Latin America. Based on the comparative advantage inherited from the colonization period, during the 1980's the region returned to the export-led growth of the colonization. The renewed outward development approach of the 1980's was characterized by creating market oriented policies and incentives for the production and exportation of agricultural primary products, and low value manufactured goods and services such as textiles and tourism (Franko, 2007).

The key economic policy variable defining the renewed outward development approach and export-led growth of the 1980's was once more the exchange rate. In that order, the exchange rate was seen as the main economic policy variable to correct balance of payments difficulties, improve the competitiveness of the export sector, and enhance export-led growth through competitive currency depreciations and undervaluation's (Gala, 2008). A series of economic reforms were undertaken in Latin America during the end of the 1980's, and during the 1990's, in order to deregulate international trade, improve the rule of law, the quality of institutions and the domestic innovation and research in new technologies (Edwards, 1995). These reforms while initially successful in improving economic growth, have not led to the expected growth and development in the region (Easterly et al., 1997, Solimano and Soto, 2005). In particular, the use of exchange rate policies to drive economic growth and development have not been satisfactory due to the negative effects that exchange rate depreciations often exert on output growth via their effects in augmenting the costs of imported goods and services.

The theoretical and empirical evidence on the role of exchange rates in driving economic growth development is in many instances controversial and inconclusive, as arguments can go in both directions as suggesting scenarios and conditions under which currency devaluations and misalignments can be growth enhancing and also growth decreasing[18]. For instance, Gala (2008), Rodrik (2008) and Razmi et al. (2012) suggests that currency devaluations and undervaluation have a positive effect on economic growth in developing countries by promoting exports competitiveness and export-led growth. On the contrary, Krugman and Taylor (1978) develops a Keynesian model where currency devaluations have a contractionary effect on output growth in countries characterized by an initial trade deficit[19]. In a rational expectations model, Agénor (1991) determine that anticipated exchange rate devaluations leads to lower output growth via an increase in the costs of labour and imported intermediate inputs of production[20]. However, in an extension of the rational expectations framework, Kandil (2004) finds that both anticipated and unanticipated currency devaluations leads to lower output growth and raising inflation.

Another branch of the existing literature ascribe to the view that monetary variables do not have a significant effect on the determinants of long run economic growth, and weak support have been found for exchange rates regimes (Baxter and Stockman, 1989, Kydland and Prescott, 1990). On the contrary, models with nominal and real rigidities have predicted monetary and exchange rates effects on output growth with substantial theoretical success (Díaz-Alejandro, 1963, Samuelson, 1964, Hirschman, 1968, Krugman and Taylor, 1978). Yet the influence that real exchange rates variations may exert on productivity growth seem to have escaped unnoticed in the existing literature.

Empirically it has been unclear whether variations in exchange rates should have any effect on productivity growth. Few studies have addressed directly the relationship from real exchange rate variations to changes in productivity. Conventionally, the effects are analysed from productivity growth to real exchange rate appreciations as in the Balassa-Samuelson effect (Balassa, 1964, Samuelson, 1964). In a recent contribution, Aghion et al. (2009) show it seems appropriate to model endogenously the relationship between exchange rates variations and productivity growth. They show that

[18] For a survey see Lizondo and Montiel (1989) and Levy-Yeyati and Sturzenegger (2010).

[19] A similar view is also shared by Hirschman (1949).

[20] In addition, Agénor (1991) also documents the use of the exchange rate as an economic policy tool for economic growth.

real exchange rate volatility and flexible exchange rate regimes may inhibit productivity growth in developing countries, being the effect sensible to the countries level of financial development.

Historically, the exchange rate has been used as an economic policy tool to drive growth and development in Latin America. In addition, it seems important to determine whether variations in the exchange rate may drive changes in productivity. Few studies have specifically address this issue, and this is an additional motivation for our research. The next section examines the evolution of productivity growth, exchange rates, exports, imports and the terms of trade in Latin America since the 1980's up to 2009.

2.3 Evidence of productivity, output and exchange rate dynamics in Latin America

Over the last thirty years since import substitution industrialization policies were replaced for a more market oriented approach, several questions have remained in relation to the Latin American growth process. For example, do variations in the real exchange rate correlate with productivity growth? Do these economies have a high content of imports relative to exports? Has export-led growth improved balance of payments conditions and alleviate the imports dependency? What has been the evolution of the terms of trend fifty years later after the Prebisch-Singer theory?

Figures 2.1 through 2.6 provide an overview of the economic structures that exists in Latin America. Figure 2.1 presents a scatter plot on the relationship between the real bilateral exchange rate and productivity growth[21]. Reading from the left axis to the right, it may appear that currency depreciations leads to higher productivity. However, if we decompose this graph into the traditional four quadrants, one may see that the vast majority of the countries located to the far right of the graph have actually experienced currency devaluations with lower productivity growth.

---

[21] The real bilateral exchange rate is in national currency per U.S. dollar. Given this definition, higher currency values indicate real depreciations. Productivity growth is defined the growth rate of output per worker.

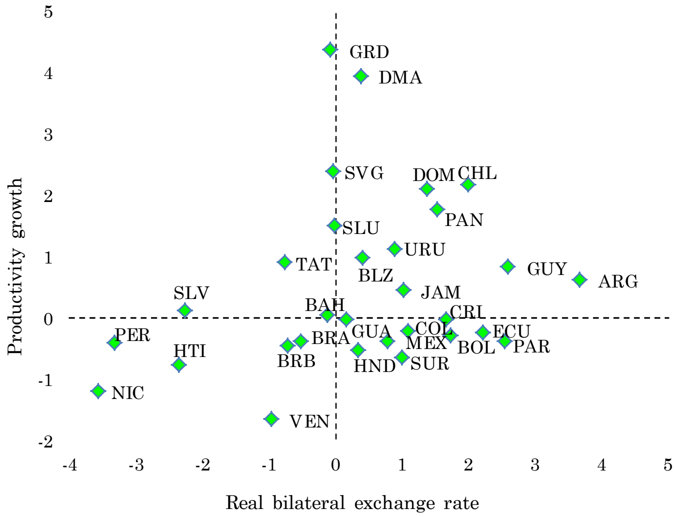

Fig. 2.1. Real bilateral exchange rates and productivity growth. Data for thirty Latin American economies from 1980 to 2009. Depreciations are defined as *increases* in the real bilateral exchange rate index. Values are in percentage changes. Source: Author calculations using data from Heston et al. (2012), World Bank (2012) and IMF (2012).

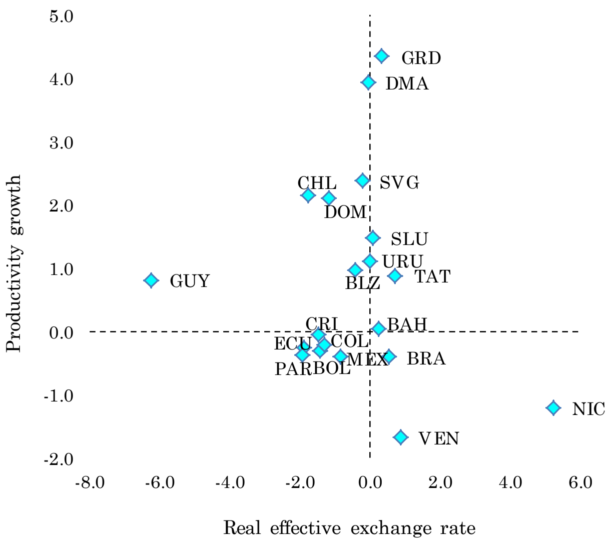

Fig. 2.2. Real effective exchange rates and productivity growth. Data for twenty Latin American economies from 1980 to 2009. Depreciations are defined as *decreases* in the real effective exchange rate index. Values are in percentage changes. Source: Author calculations using data from Heston et al. (2012), World Bank (2012) and IMF (2012).

In addition to the bilateral comparison, Figure 2.2 present the relationship between the real effective exchange rates and productivity growth[22]. In this case, currency devaluations are defined as decreases in the effective exchange rate index. In that order, Figure 2.2 suggests that currency devaluations correlate with lower productivity growth, or in other words that high productivity growth correlates with real exchange rate appreciations. The evidence suggests that countries characterized by high productivity may also experience real exchange rate appreciations.

An important question is whether the Latin American economies are characterized by high levels of goods and services imports. Figure 2.3 present evidence on the exports and imports volumes in the region. The data indicates that the exports volume is relatively lower than the imports volume. More specifically, exports have grown on average 1.12% less than imports. In other words, the growth rate of imports has outpaced exports growth. Since the 1990's several Latin American economies have experienced significant growth episodes. In that order, an important question relates to whether growth correlates with a high volume of imports relative to exports.

The potential growth effects of real exchange rate variations may be operating through variations in the terms of trade. Examining the evolution of the terms of trade during the last thirty years, Figure 2.4 presents evidence indicating that the terms of trade in the region have actually declined on average 0.18% since 1983. Consequently, the data indicates that on average import prices are relatively higher than export prices. The evidence presented in Figure 2.4 also suggests that the region have experienced significant improvements in the terms of trade during several years. In that order, it is unclear whether the evolution of the terms of trade is the cause or the consequence of economic growth in the region.

[22] The real effective exchange rate refers to a basket of currencies.

Fig. 2.3. Trade volumes in Latin America, 1985-2008. Goods and services exports and imports volumes. Values are in percentage changes. Source: Author calculations and IMF (2012).

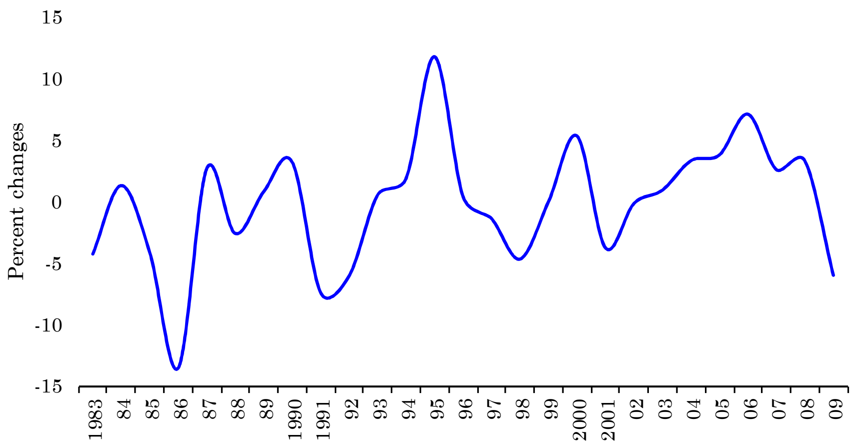

Fig. 2.4. Terms of trade in Latin America, 1983-2008. Terms of trade for goods and services. The terms of trade are traditionally defined as the export unit values divided by the import unit values according to the definition provided by the world table methodologies of the International Financial Statistics (IFS). Values are in percentage changes. Source: Author calculations and IMF (2012).

The Latin American economies seem to rely structurally on high volumes of goods and services imports to drive economic growth. To the extent that import prices are relatively higher than export prices, these economies will sustain persistent current account deficits. These current account deficits should persist even if these countries followed an economic policy of competitive exchange rate devaluations in order to reduce the relative prices of their exports to promote their international demand.

Figure 2.5 depicts the relationship between the current account balance and the real effective exchange rate. The evidence seems mixed; however, there are two characteristics worth mentioning: first, the vast majority of Latin America economies registered trade deficits since the 1980’s. Second, the trade deficits persisted even in the context of real effective exchange rate depreciations. Apparently, currency devaluations have not induced the expected improvements in the current account balance.

Finally, we address the imports dependency in the region. Our main question is the following: Have the imports dependency been reduced in Latin America since the 1980’s? Figure 2.6 suggest that since 1995 the import share of GDP has actually increased in relative terms to the 1980-1994 period. The import share of output has intensify as economic growth have improved in the region since the economic reforms of the 1990’s. Overall, the data indicates that the vast majority of the Latin American economies have a high dependency to imports of goods and services, and this dependency have actually increased since 1995.

Several caveats in the present analysis are worth mentioning. First, scatter plots are based on averages, which are prone to outliers and structural breaks in the time series. Second, reverse causation or endogeneity may result in spurious causality or correlations if these are not properly addressed in a formal empirical model. To surpass these issues, in the next section we propose an empirical productivity growth model. We address the potential endogeneity amid productivity growth and other potential growth determinants. We provide a description of the estimation and data methodology, as well as the programing used to estimate the growth model.

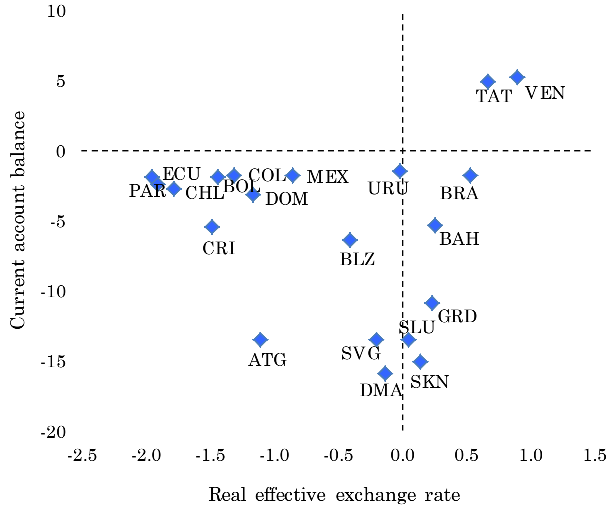

Fig. 2.5. Real effective exchange rates and current account balance, 1980-2009. Data for twenty Latin American economies. Depreciations are measured as *decreases* in the real effective exchange rate index. The effective real exchange rate refers to a basket of currencies. Current account balances as a percentage of GDP. Values are in percentage changes. Source: Author calculations and IMF (2012).

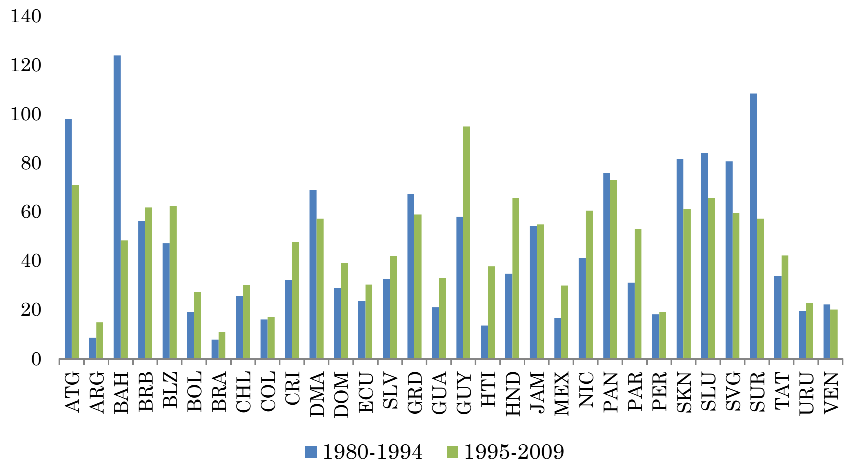

Fig. 2.6. Total imports of goods and services, 1980-2009. Data for thirty-two Latin American economies. Values as percentage (%) of GDP. Source: Author calculations and IMF (2012).

2.4 Methodology: accounting for productivity growth and the exchange rate

Whether productivity variations have an effect on the real exchange rate have been an important question in the literature. Examining these dynamics, for example, Harrod (1933), Balassa (1964) and Samuelson (1964) concluded that productivity growth drive real exchange rate appreciations[23]. This view, however, does not take into consideration the possibility of simultaneous feedbacks or endogenous effects between the real exchange rate and productivity. In this chapter we examine the hypothesis that real exchange rate variations may drive productivity growth. In particular, we estimate a productivity growth model where productivity variations are explained by changes in the real exchange rate, currency misalignments, nominal real exchange rate regimes, and other important growth determinants.

An estimation procedure that does not take into account the endogeneity or simultaneity bias in growth regressions may render the estimates biased and inconsistent. In order to address the potential endogeneity of the growth determinants and the real exchange rate we require the use of instrumental variables estimation procedures for dynamic panel data models that allows the inclusion of several endogenous repressors. Among the wide range of dynamic panel data estimators, one particular kind of estimator show substantial consistency and asymptotic efficiency properties for the estimation of dynamic panel data models with a large number of countries and a relatively small number of time period, such as the ones that characterizes growth regressions. These sets of models are contained within the framework of the Generalized Method of Moments (GMM) estimation.

Conventionally, the alternative to the GMM estimation of dynamic panel data models has been the within-group (fixed-effects) estimation, and the two-stage least-squares (2SLS) estimation. In the context of dynamic panel data models with endogenous repressors, however, the fixed-effects estimator may not perform well and may not show consistency while the 2SLS estimator can only handle a limited number of endogenous variables. In addition, the inclusion of the lagged dependent variable and other endogenous repressors

[23] For a review see Obstfeld and Rogoff (1996).

may render invalid the exogeneity assumption of the fixed effect estimation[24]. Moreover, in growth theory the adoption of the exogeneity assumption may lack empirical support (Caselli et al., 1996). In addition, the fixed effect estimator has been shown to induce parameter instability and large biases when the time series are persistent, such as the one that characterizes the GDP series (Durlauf et al., 2005). Another issue in the estimation of dynamic panel data models is the usual presence of heteroskedasticity and serial correlation within individuals. In this context, as in many others, the GMM estimator outperform other panel data estimators for its ability to control and produce robust standard errors to heteroskedasticity and autocorrelation within cross-sectional units (Wooldridge, 2001).

Based on the works of Anderson and Hsiao (1982), Chamberlain (1984) and Holtz-Eakin et al. (1988), Arellano and Bond (1991) introduced the first difference GMM estimator for dynamic panel data models in a one-step and two-step variants[25]. This type of instrumental variable (IV) estimators consists of estimating an equation in first differences for which lagged levels of the variables are then used as instrument. In that order, the lagged levels of the variables are shown to remain orthogonal to the error component, and therefore are valid instruments for the first difference equation.

The advantages of this procedure is that the first difference transformation removes the time invariant unobserved heterogeneity, and the use of lagged levels as instruments produce consistent estimates in the presence of endogeneity and measurement error. An important drawback of this estimator is that past growth rates may not predict well future changes, that is, lagged levels may be weak instruments of future growth rates. Moreover, given the persistency of the GDP series, this estimator in many Monte Carlo simulations show poor finite sample properties (Bond et al., 2001). In the two-step variant of the estimator, the first difference estimator showed a downward bias in small samples, that is, the standard errors tend to be relatively lower, and therefore the estimated parameters may show a higher than expected significance level.

---

[24] Under the exogeneity assumption the explanatory variables should not correlate with the error component.

[25] Theoretically, the two-step estimation is asymptotically more efficient that the one-step estimation (Roodman, 2009a).

In an attempt to improve the asymptotic consistency and efficiency properties of the first difference estimator, Arellano and Bover (1995) suggested the inclusion and simultaneous estimation of another equation in levels for which lagged first differences of the covariates and the dependent variable are then used as instruments. This approach was further extended by Blundell and Bond (1998) which provided the additional assumptions and moment conditions under which this new system of equations may produce consistent and efficient estimates for dynamic panel data models with a relatively small number of time periods and large cross-sectional units[26].

In what follows, to address the potential endogeneity of the growth determinants, we estimate a productivity growth model using the system generalized methods of moment's estimator. More specifically, our model is estimated using the programming proposed by Roodman (2009a) for the two-step Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) system GMM estimator corrected for finite sample bias using Windmeijer (2005) robust standard errors, small sample adjustments and Roodman (2009b) collapsed instruments. In that order, the standard errors are robust to heteroskedasticity and autocorrelation within cross-sectional units.

2.4.1 Productivity growth model

The application of system GMM estimations to growth models where the exchange rate is a key growth determinant have been pioneered in recent years by Gala (2008), Aghion et al. (2009) and Razmi et al. (2012). In that order, our baseline productivity growth equation is derived from the following output per worker equation:

$$y_{l,t} = \theta y_{l,t-1} + \delta r_{l,t} + \beta \Omega'_{l,t} + \tau_t + c_{l,t} + v_{l,t} \qquad |\theta| < 1 \tag{2.1}$$

where $y_{l,t}$ denotes output per worker, $y_{l,t-1}$ is the initial output per worker level, $r_{l,t}$ is a measure of different specifications for real exchange rate changes, currency misalignments and nominal exchange rate regimes, where

[26] Since the two-step GMM estimation was still prone to finite sample bias, Windmeijer (2005) introduced a finite sample correction to produce consistent standard errors and lower bias in the context of small sample.

δ is the respective exchange rate coefficient[27], $\Omega_{l,t}$ is a column vector of control variables, τ_t are the time period specific effects, $c_{l,t}$ is a measure of the country specific effect or time invariant unobserved heterogeneity, and $\nu_{l,t}$ denotes the classical error term or idiosyncratic shock. The set of countries are $l \in [1, \dots, 32]$ Latin America economies, and the time periods are $\tau \in [1, \dots, 6]$ five-year averages from 1980 to 2009[28].

Equation (2.1) can be re-expressed in its productivity growth form by subtracting $y_{l,t-1}$ from both sides:

$$y_{l,t} - y_{l,t-1} = (\theta - 1)y_{l,t-1} + \delta r_{l,t} + \beta\Omega'_{l,t} + \tau_t + c_{l,t} + \upsilon_{l,t} \tag{2.2}$$

Therefore, we estimate the following productivity growth equation:

$$y_{l,t} - y_{l,t-1} = \lambda y_{l,t-1} + \delta r_{l,t} + \beta\Omega'_{l,t} + \tau_t + c_{l,t} + \upsilon_{l,t} \tag{2.3}$$

where $\lambda = (\theta - 1)$. A negative and significant coefficient will be consistent with the conditional convergence hyphotesis in neoclassical growth models. The conditional convergence hyphotesis suggests that countries closer to their steady state levels will experience slower growth rates[29].

Adding $y_{l,t-1}$ to both sides of (2.3) verify that this equation is identical to (2.1). In that order, Eq. (2.1), (2.2) and (2.3) are equivalent. The coefficient of the lagged dependent variable plays an important role in Eq. (2.1)[30]. It is standard in growth econometrics to assume that $|\theta| < 1$. This assumption implies that disturbances from the error component, or idiosyncratic shocks, dissipate over the long run and therefore the dependent variable converges towards mean stationarity conditional on the explanatory variables. In other

[27] Since the hypothesis being tested is that currency depreciations leads to lower productivity growth, the value of the coefficient is expected to be negative ($\delta < 0$). This is the case when the real exchange rate is defined in national currency per foreign currency, where a rise in the exchange rate index denotes a currency depreciation or devaluation.

[28] See the data section for additional details on the variables definitions and sources.

[29] For a detailed discussion on conditional convergence in growth theory see Barro and Sala-i-Martin (1992), Caselli et al. (1996) and Acemoglu (2009).

[30] Throughout this chapter the term variable and covariates is used interchangeably.

words, countries will eventually converge to their long-run mean levels of productivity conditional on the explanatory variables[31].

When the model is expressed in its productivity growth form (Eq. 2.3) a negative lagged dependent variable coefficient (that is $\lambda < 0$, where $\lambda = \theta - 1$) imply conditional convergence. In this case, productivity growth will tend to subside once the countries approach to their steady state levels of output per worker (Caselli et al., 1996). This conditional convergence hypothesis will be consistent with mean stationarity when in (2.3) the coefficient of the lagged dependent variable is negative and significant, ranging between $-2 < \lambda < 0$ which correspond to $|\theta| = |\lambda + 1| < 1$ in (2.1)[32]. The intuition behind this result could be important: conditional convergence may not imply mean stationarity, however a mean stationarity process imply conditional convergence.

The GDP and output per worker series are usually highly persistent. In that order, if we consider that real exchange rate depreciations decrease productivity growth rates, these shocks will take longer to decay for the economy to return to its steady state level of productivity. In a similar argument, persistent and systematic real exchange rate depreciations will continuously keep decreasing productivity growth, maintaining the economy below its productivity potential, and sustaining a technological disparity between the developing economy and the industrial leader. This intuition draws on the technological disparity hypothesis suggested by Prebisch (1950), Singer (1950) and Prebisch (1959).

The estimation of growth models of the type described by Eq. 2.3 requires the use of dynamic panel data estimation methods that allows for a dynamic process, and results in the consistent and efficent estimation of the parameters in the context of persistent time series and several endogenous regressors. Bond et al. (2001) suggests the use of the system GMM estimator as the appropriate estimation procedures for empirical growth models of

---

[31] The case in which $|\theta| = 1$ may occur when fixed effects are not present, in which case an alternative estimation method can be implemented. If $|\theta| > 1$ any disturbance of the errors or shocks induces a divergent process in the dependent variable and any equilibrium or stationarity point will be unstable. When $|\theta| = 0$ this implies a non-dynamic process and hence dynamic panel data estimation is not needed. For a detailed discussion on these issues see Caselli et al. (1996) and Roodman (2009a).

[32] Note that in this case growth rates are not expressed in percentage terms. When growth rates are expresses in percentage terms, we should multiply by 100.

these form. In that order, the system GMM estimation of Eq. (2.3) proceeds with the simultaneous estimation of two equations: one in first differences and another one in levels[33]. The estimator use lagged levels of the variables as instruments the first difference equation, and lagged first differences of the variables as instruments for the level equations[34].

A high instrument count in the system GMM estimations may weaken the specification tests and results in biased estimates. Consequently, it is important to properly reduce the instrument count. Although there is none universally accepted procedure to reduce instrument count in system GMM estimations, we follow the programming proposed by Roodman (2009a, b). According to this strategy, a general rule of thumb is to limit the number of instruments to be equal to the number of countries or cross-sectional units.

To achieve the objective of reducing the instrument count to the number of countries we follow two approaches. First, we limit the number of lags to be used as instruments for each variable. The number of lags is limited up to the third lag in our estimations. Second, we follow the collapsed instruments approach proposed by Roodman (2009b). According to this approach, one instrument is created for each variable and lag distance, and zero for missing values. As a consequence of these approaches, the instrument account is linear to the number of time periods[35].

The validity of the instruments used in our estimations is tested through the Hansen (1982) *J t*est of over-identified restrictions under the null of joint instrument validity. We use the Hansen test since our standard errors are robust to heteroskedasticity, and under this conditions the two-step Sargan (1958) statistics is not robust, and tend to under reject the null of instrument validity (Arellano and Bond, 1991). In addition, we use the Difference-in-Hansen test under the null of instrument validity in order to test specifically for the validity of the subset of instruments used in the level equations, which

[33] The additional assumptions and moment conditions of the system GMM estimation are detailed in Appendix A.3.

[34] The use of lags as predictors for growth appear plausible as variations in productivity and the growth determinants may take a considerable amount of time to have an effect on macroeconomic conditions.

[35] In the uncollapsed version, one instrument is created for each variable, lag distance and time period, which may create many instruments. In that order, collapsing the number of instruments and reducing the number of lags have proven to yield consistent and efficient estimates (Roodman, 2009b).

validates the use of system GMM, as well as to test for the validity of the instruments used in the first difference equations.

The Hansen statistics can also be considered as a test for the model misspecification and omitted variables bias. If variables are omitted from the model these should be captured by the residuals, inducing a correlation between the error component and the instruments. In that order, as instruments may be invalid in this case, this source of instrument invalidity is likely to be captured by this specification test.

The validity of the moment conditions crucially depend on the non-serial correlation assumption of the error term, apart from the one that may result from the fixed effects. In that order, we use the Arellano and Bond (1991) serial correlation test under the null of no serial correlation in order to test whether the instruments used in the estimations are strictly exogenous, meaning they remain orthogonal to the error component[36]. Given the first difference equation transformation, first order serial correlation is expected in the idiosyncratic shock, therefore for the levels equation it suffices to inspect for second order serial correlation.

To control for unobserved heterogeneity in our estimations, we include country specific effects. In that order, the first difference transformation of Eq. (2.3) removes the time invariant unobserved heterogeneity. Since most Latin America economies display common patterns of culture, language, religion and market structures, we should expected time-varying heterogeneity to be relatively insignificant in the region, and therefore we do not model it specifically.

As opposed to the estimation of large cross-country regressions between different world regions, and economies with different economic structures, laws, politics, institutions, culture, and levels of technological efficiency, the Latin American countries offer a unique scenario to undertake growth research. The gains that could be achieve by modelling heterogeneity specifically for the region, and then incorporating these differences into our estimation framework may prove uninformative and insignificant for our

[36] Note that it is standard to assume in these estimations that errors do not correlate across countries. The inclusion of time dummies may capture patterns of common shocks and correlation patterns across countries. For a detailed discussion see Bond et al. (2001) and Roodman (2009a).

results. Moreover, including regional dummies in the estimation virtually makes no difference to our results. Most of these economies have been characterized by persistent trend towards currency depreciations and slow productivity improvements. Nevertheless, within the estimation framework, the inclusion of period specific effects may capture common time varying factors that may affect these economies.

2.4.2 Data

We compiled a macroeconomic panel dataset for the thirty-two economies classified in Latin America according to the International Monetary Fund (2012a) classification[37]. The time period of the data covers 30 years from 1980 to 2009, and the panel is unbalanced. As is standard in growth econometrics, we take five-years averages of the data to filter out business cycles fluctuations (Durlauf et al., 2005).

The main data sources of the variables are the World Development Indicators (WDI), the International Financial Statistics (IFS) and the Penn World Tables (PWT)[38]. In our model, the dependent variable is productivity growth, defined as the growth rate of output per worker[39]. Since we are interested in the growth effects of real exchange rate variations on productivity, we construct five different alternative measures of real exchange rates. These specifications follows the definitions of real exchange rates provided by Ellis (2001) and Catão (2007).

Our first measure of real exchange rate is a bilateral real exchange rate index with respect to the United States (U.S.) dollar, adjusted by the consumer price indexes differentials between the United States and the

[37] This classification excluded Anguilla (United Kingdom, UK), Aruba (The Netherlands), Bermuda (UK), British Virgin Islands (UK), Cayman Islands (UK), Cuba, Falkland Islands (UK), French Guiana, Guadeloupe (France), Martinique (France), Montserrat (UK), Puerto Rico (U.S.), Turks and Caicos Islands (UK). For a discussion on why these countries are not included in the Latin America classification see International Monetary Fund (2012b).

[38] Appendix A.6 summarizes all the definition and sources of the variables. In particular, this section focuses on explaining why these variables are relevant for our study.

[39] In particular, we use data of the PPP converted GDP per worker at 2005 constant prices (chain series) from Heston et al. (2012).

domestic economy[40]. Our second and third measure for real exchange rate are a bilateral exchange rate index calculated using the producer's price indexes and the wholesale price indexes. These adjustments may lessen the influence that the evolution of non-tradable prices may exert on the price indexes and consequently on the exchange rate measures[41].

The fourth definition of real exchange rate is a real exchange rate index adjusted by purchasing power parity (PPP) using data obtained from the PWT, and constructed following the methodology proposed by Rodrik (2008). In addition, our fifth measure is the real effective exchange rate indexes reported by the International Monetary Fund (IMF). The effective exchange rate index is calculated as the weighted averages of a basket of currency values of selected trade partners adjusted by prices or costs indexes[42].

A vast empirical literature often suggest a positive growth effect of currency misalignments on economic growth, and possibly on productivity[43]. To address this hypothesis, our estimations also account for the growth effects of real exchange rate misalignments on productivity growth. For this aim, we construct two alternative measures for currency misalignments.

Our primary specification for real exchange rate misalignment is an undervaluation index constructed following the three-step methodology proposed by Rodrik (2008). In the first step, we calculate the real exchange

---

[40] The real bilateral exchange rate comparison with respect to the United States is mostly based on statistical convenience and data availability, as the U.S. is the main trade partner of the vast majority of the Latin American economies. Data exclude the extreme observations for the real exchange rate growth and volatility measures corresponding to Nicaragua (1985-1989) and Suriname (1990-1994). These extreme observations are suspected to be the results of data recording errors or structural breaks in the series. For a survey on the detection and correction mechanisms for influential and outlaying observations see Donald and Maddala (1993).

[41] Changes in the bilateral index are measured by logarithmic differences, while its volatility is measured by the standard deviation of annual growth rates within each five year interval (Husain et al., 2005, Aghion et al., 2009).

[42] The construction of multilateral real exchange rate measures for the Latin America economies has proven to be a difficult task due to the scant data availability. Not all the statistics needed for the construction of a multilateral real effective exchange rate are available. Such statistics includes trade weights, prices measurements and bilateral rates between all the trading partners and the domestic economy. Specifically, in very limited cases these statistics are available for extended time periods.

[43] See, for example, the works of Gala (2008), Rodrik (2008), Razmi et al. (2012) and Couharde and Sallenave (2013).

rates adjusted by PPP conversion factors[44]. In the second step, we adjust by Balassa-Samuelson effects by estimating the equilibrium real exchange rate from the fitted values of the following equation:

$$\hat{r}^{*}_{l,t} = \hat{\alpha} + \hat{\gamma} Y_{l,t} + \tau_{l,t} + \mu_{l,t} \tag{2.4}$$

Where $r_{l,t}$ denotes the real exchange rate adjusted by the PPP conversion factors, $Y_{l,t}$ is the real GDP per capita, $\tau_{l,t}$ are the respective time fixed effects, and $\mu_{l,t}$ is the corresponding error term[45]. In that order, the estimates for the equilibrium real exchange rates $(\hat{r}^{*}_{l,t})$ are obtained from the fitted values of the regression of the real exchange rate on real GDP per capita with the appropriate constant and time fixed effects.

In accordance with the estimation of Eq. (2.4), the Balassa-Samuelson effect in Latin America is $\hat{\gamma} = -0.18$, that is, a 10% increase in GDP per capita leads to a 1.8% appreciation in the real exchange rate[46]. In other words, a relatively higher productivity growth in the tradable sector—in comparison to the non-tradable sector—leads to an appreciation of the real exchange rate in Latin America.

Our estimation for the Latin American Balassa-Samuelson effect goes in line with previous findings in the literature. For example, Rodrik (2008) estimated the Balassa-Samuelson effect to be approximately -0.24 in a sample of 188 countries over the period from 1950 to 2004[47]. Applying a similar methodology in a sample of advanced and emerging market economies from 1980 to 2009, Couharde and Sallenave (2013) found a Balassa-Samuelson effect of -0.34. In addition, Razmi et al. (2012) estimated a an effect of -0.24 in a sample of 153 countries during the period from 1960 to 2004.

---

[44] That is, the ratio of the nominal exchange rate to PPP. Data for the nominal exchange rate (xrat) and purchasing power parity over GDP (PPP) are in national currency per U.S. dollar. Data is obtained from Heston et al. (2012) . All variables are expressed in logarithms and calculated as five-year averages for each country over the sample period.

[45] The real GDP per capita is the PPP converted GDP per capita (chain series) at 2005 constant prices (Heston et al., 2012).

[46] The Balassa-Samuelson effect is represented by the $\hat{\gamma}$ coefficient of the real GDP per capita variable, and is negative and significant for the region.

[47] Rodrik (2008) also reported an estimated effect of -0.22 given the revised 2005 PPP conversion factors by the World Bank's International Comparison Program.

A possible drawback of this methodology is that it assumes a one direction causal relationship from variations in real GDP per capita to changes in the real exchange rate. Moreover, the real GDP per capita ($Y_{l,t}$) variable must satisfy the exogeneity assumption for the pooled regression model of equation (2.4) to be unbiased and consistent. Another important aspect is that Eq. (2.4) assumes a constant term coefficient for all the countries in Latin America. However, since we are imposing the assumption of the law of one price there is no reason to believe that different constant coefficients or unobserved heterogeneities may play a significant role in disrupting the law of one price. Nevertheless, this methodology offers the great advantage of producing currency misalignment measures that are easily comparable across countries, and are readily available for most of the countries across different time periods; as opposed to estimates that could be obtained from country specific macro-simulated models. Furthermore, our interest in this case is in capturing equilibrium real exchange rate based on the law of one price[48].

Finally, in the third step of the estimation methodology, the undervaluation index is defined as the logarithmic deviation of the real exchange rate from its equilibrium value:

$$\mu_{l,t} = r_{l,t} - r^*_{l,t}$$

where $\mu_{l,t}$ is the undervaluation measure, $r_{l,t}$ denotes the real exchange rate based on PPP conversion factors and $r^*_{l,t}$ is the equilibrium exchange rate estimated from equation (2.4). Under this definition, the currency is said to be undervalued when $\mu_{l,t} > 1$ and overvalued when $\mu_{l,t} < 1$.

Our second alternative specification for currency misalignments in Latin America is an undervaluation series that controls for stochastic trends following a modified version of the Goldfajn and Valdes (1999) methodology. In that order, the undervaluation series is defined as the logarithmic deviation of the real exchange rate from its stochastic trend or equilibrium

[48] To improve on any possible drawbacks of this methodology, fixed and random effects panel estimations where preformed based equation (2.4). These estimations resulted in $\hat{\gamma} = -0.31$ for the fixed effects model, and $\hat{\gamma} = -0.24$ for the random effects model. Overall, based on the assumptions of the law of one price, the pooled OLS estimation of Eq. (2.4) offer a more consistent and comparable estimate across countries and time periods.

value calculated using a Hodrik-Prescott (HP) filtered series with a smoothing parameter defined by the Ravn and Uhlig frequency power rule[49].

The Goldfajn and Valdes (1999) methodology suggests that the filtered series denotes the stochastic trend that characterize the equilibrium real exchange rate. In that order, the undervaluation series characterize the misalignment or cyclical component that proxies departures from the law of one price. Consequently, an undervaluation episode is defined as the deviation of the real exchange rate from its equilibrium value. Conversely, deviations below the equilibrium denotes currency appreciations[50]. More formally, with a normalization of 100, the undervaluation series are calculated as the departures of the real exchange rate from its equilibrium value[51]:

$$\epsilon^{o}_{l,t} \equiv 100 + 100\frac{(r_{l,t} - \hat{r}_{l,t-1})}{\hat{r}_{l,t-1}}$$

where $\epsilon^{o}_{l,t}$ denotes the undervaluation series, r defines the real exchange rate for country l at time t. In that order, $\hat{r}_{l,t}$ denotes the estimated equilibrium real exchange rate using the Hodrik-Prescott filter.

Our interest in this methodology relies on its ability to produce equilibrium real exchange rate values that time-vary endogenously with the data generating process. In addition, this methodology is not limited by data availability. Moreover, this methodology also offers consistent estimates of equilibrium exchange rates that are easily comparable across countries.

Nominal exchange rate regimes have also been suggested to be significant drivers of macroeconomic performance in developing countries, particularly in Latin America (Husain et al., 2005, Frenkel and Rapetti, 2011). To address

---

[49] For annual frequencies, the Rav and Uhlig frequency power rule suggests a smoothing parameter of $\lambda = 6.25$ for the Hodrik-Prescott filter (Ravn and Uhlig, 2002).

[50] Nominal exchanges rates are defined in national currency per U.S. dollar. As a consequence, real exchange rate appreciations are defined as decreases in the undervaluation series.

[51] Goldfajn and Valdes (1999) defines the start of a currency misalignment as a deviation of the real exchange rate from its equilibrium value greater than or equal to +/- 15%. We have extended this definition to account for any deviation of the real exchange rate from its equilibrium value to be a form of currency misalignment no matter how small may be. For our case it seems best to adopt this extended definition.

this hypothesis in our estimations, we construct three alternative definitions of nominal exchange rate regimes for the region.

Our primary specification is the natural classification of modern exchange rate arrangements developed by Reinhart and Rogoff (2004) and further extended by Ilzetzki et al. (2008). In particular, we selected the coarse grid taxonomy of this classification[52]. Ranging from lower values for more rigid arrangements, to higher values for more flexible ones, the primary classification of the coarse grid can be defined as: $\Re \in [1,2,3,4,5,6]$ = [no separate legal tender and pre announced peg and band, pre announced and de facto crawling peg and band, managed float, free float, free fall, dual and parallel currency markets]. Given this definition, we calculated the average exchange rate regime that prevailed in each Latin American economy during each five-year interval (Aghion et al., 2009).

Our second specification for nominal exchange rate arrangements is the Levy-Yeyati and Sturzenegger (2005) de-facto classification. In particular we use the extended 3-way de facto classification. Due to data availability for the Latin American economies, the extended 3-way classification is more convenient as it increases the number of available observations for each country[53]. This specification use lower values to denote flexible arrangements, and higher values to denote fixed exchange rate regimes: $\mathcal{L}_t \in [1,2,3]$ = [float, intermediate, fix]. The regime that prevailed in each country is defined as the average exchange rate arrangement that prevailed during each five-year interval.

The third definition of exchange rate regimes use the IMF de-jure classification for nominal exchange rate arrangements and follows the coarse grid taxonomy of Ilzetzki et al. (2008). This classification is defined as the exchange rate arrangement that the governments reported to be the official exchange rate regime prevailing in the country. As in the natural classification, higher values of the de-jure classification denotes more flexible exchange rate arrangements[54].

---

[52]. Our focus is on the broad exchange rate regime categories, rather than examining all the wide variety of sub-regimes in each regime category.

[53] For an extended discussion on the benefits of the extended 3-way classification see Levy-Yeyati and Sturzenegger (2005).

[54] Data for the de-jure classification proceeds from Ilzetzki et al. (2008).

Our estimations use a variety of growth determinants that serve as control regressors to isolate the growth effects of real exchange rate variations, currency misalignments and nominal exchange rate regimes on productivity growth. Our primary set of control regressors follows those adopted by Rodrik (2008), Aghion et al. (2009) and Razmi et al. (2012). As is standard in growth regressions, we introduce a control for the initial level of efficiency or productivity, that is, a measure for initial output per worker at the beginning of each five-year period. In addition, our primary set of control regressors includes the level of trade openness, government consumption, inflation, and a measure for banking and currency crisis.

The control regressor for trade openness intends to capture the countries exposures to variations in the patterns of international trade, and changes to the trade volumes[55]. The measures for government consumption and inflation are included to control for the main aspects of fiscal and monetary policy[56]. The control for banking and currency crisis intends to capture severe episodes of macroeconomic distress that may distort the foreign exchange and credit markets that may lessen the productive capacity of the economy. Such episodes are normally characterized by banking and currency crisis. Our measure for banking and currency crisis draws on the data and methodology proposed by Reinhart and Rogoff (2009) and Laeven and Valencia (2010).

As a robustness check to alternative control variables specifications, our estimations also control for other important growth determinants. Following Barro (2001) and Barro and Lee (2010), we control for the effects of human capital on productivity growth by including a control for the educational attainment level of the population aged 16 and over. In addition, we control for the level of institutional development by including Henisz (2002, 2010) political constraint index, or veto points over the institutional constraints to policy changes. The level of institutional development has been suggested to

---

[55] Astorga (2010) show that trade openness, through its enhancing effect via the investment channel, may be an important driver of output per worker growth in Latin America. In addition, we control for the imports dependency in these economies by introducing a control for the total imports of goods and services. A high level of imports may increase the growth effects of the real exchange rate on productivity, therefore, we control for this possibility.

[56] Inflation is defined as the lack of price stability, and is calculated as the logarithm of one plus the growth rate of the consumer price index (Levy-Yeyati et al., 2010).

be an important driver of economic growth and macroeconomic performance in Latin America (Acemoglu et al., 2001, 2003). In addition, we also control for gross savings and the gross capital formation in these economies as proxies for savings and investment. These measures for savings and investment are included to control for the main determinants of investments in capital accumulation and productivity.

Since the use of domestic and external debt has been historically important in Latin America, in particular after the debt crisis of the 1980's, our estimations also control for external debt stocks and financial development. Our measure for external debt stocks proceeds from the World Development Indicators, along with the measure for domestic credit to the private sector which serve as proxy for financial development[57]. In addition, we also introduce an alternative specification for financial development, that is, a dummy variable that indicates whether the economy is listed as an emerging market or a developing country. This latter definition follows the financial development classification proposed by J.P. Morgan (1999) EMBI global index, the International Monetary Fund and FTSE. (2012). These measures for financial development control for emerging market economies which may have a better access to international capital markets, a higher degree of sophistication in the design of economic policy, and additional macroeconomic stability that may lead to a better allocation of resources and higher flows of foreign direct investment which may improve productivity.

Finally, following the Prebisch-Singer theory, our estimations also control for the evolution of the terms of trade. Due to data availability, the terms of trade are defined as exports as capacity to imports, and data proceeds from the World Development Indicators. Accounting for the evolution of the terms of trade is relevant for our estimations as higher import prices may cause the real exchange rate to depreciate thus leading to restrictions in the adoption of foreign physical capital which may reduce the productive capacity of the economy. In that order, controlling for variations in the terms of trade may serve to control for the possibility that the growth effects of real exchange rate variations may be operating through changes in the relative prices of traded goods and services.

---

[57] This measure of financial development is closely related to the one defined by Levine et al. (2000) and Aghion et al. (2009).

2.4.3 Estimation procedure

To estimate the growth effects of real exchange rate variations, currency misalignments and nominal exchange rate regimes on productivity growth, we estimate Eq. 2.3 using the Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) system GMM estimator with Windmeijer (2005) robust standard errors, small sample adjustments, and collapsed instruments, following the estimation program proposed by Roodman (2009a, b).

The identification of the system GMM specification to be implemented in the estimation of Eq. (2.3) followed a three-stage identification procedure. In the first stage, the equation is estimated using all the available instruments and different control regressors. The objective of this procedure is to determine how the coefficient estimates were influenced by the inclusion of potential omitted variables and additional instruments. Our preliminary results indicated that due to the number of countries and the time periods under examination, the inclusion of many instruments and many control regressors may result in inconsistent estimates and over-identification of the model. In that order, a standard set of control regressors should be defined across all the estimations to maintain the comparability and consistency of the estimation results.

The second stage of the identification procedure tested for the use of different lag choices for the available instruments, as well as for different matrix of moment's specifications. We initially assumed the strict exogeneity of all the regressors, however, the preliminary results indicated that specifying the variables as uncorrelated with the idiosyncratic shock (exogenous) was not a valid identification[58]. By invalid identification it is meant that the Hansen J statistic or the Difference-in-Hansen statistic fell below our specified lower bound rejection region of a p-value less than 0.15 for the null hypothesis of valid instruments. In contrast, the specifications were shown to be valid when the measures for exchange rates and the control regressors were treated as endogenous variables[59]. A selection of two lags for

---

[58] This confirms Caselli et al. (1996) claim that the exogeneity assumptions is not appropriate for growth regressions.

[59] Recall that time effects are conventionally treated as strictly exogenous, see Roodman (2009a).

the endogenous variables, and up to two lags for the predetermined lagged dependent variable, were found to be appropriate across various estimations[60].

Finally, the last stage of the identification procedure reduced the set of control regressors to those that under different specifications showed significant effects on productivity, and could largely reduce any omitted variables bias that could potentially arise in the estimations. Such primary standard set of control regressors includes, but are not limited to, the trade openness, government consumption, inflation, and the measure for banking and currency crisis[61].

Our interest is in the estimation of the exchange rate coefficient δ in Eq. (2.3). In that order, the optimal estimate of this equation should display the following properties. First, the objective parameter, that is the exchange rate coefficient, should display parameter stability. This imply that its value under different control variables specifications, and selection of instruments, should remain fairly stable. Second, the Hansen statistic and the Difference-in-Hansen statistic of the model should indicate the acceptance of the null hypothesis of valid instruments. Finally, the exchange rate coefficient should be negative and significant when depreciations are defined as increases in the exchange rate index, or positive and significant when depreciations are defined as decreases in the real exchange rate index. In other words, the exchange rate coefficient should display the property of stable and significant sign reversal under alternative specifications and definitions.

2.5 Results

2.5.1 Real exchange rate effects on productivity

The first question to be addressed in our estimations is whether variations in the real exchange rate have significant effects on productivity growth in Latin America. The second question relates to whether real exchange rate depreciations correlates with higher or lower productivity; and the third

[60] See Appendix B for additional robustness checks.

[61] These control variables have often been suggested to be key predictors of growth. Rodrik (2008), Aghion et al. (2009) and Razmi et al. (2012) also include some these controls regressors in their estimations.

question address whether the real exchange rate effect on productivity is statistically significant despite accounting for different determinants of productivity growth. To answer these questions, we estimate Eq. (2.3) using the system GMM methodology described in Section 2.4.

Table 2.1 reports the estimation results for the real exchange rate effects on productivity[62]. First, we can observe that the real exchange rate coefficient is relatively stable across a variety of different specifications, namely that: $\delta \in (-0.11, -0.21)$. In response to our initial three questions, the results presented in Table 2.1 show there is a negative and statistically significant growth effect of real exchange rate variations on productivity. The contractionary effect of currency depreciations on productivity is statistically significant, negative, and robust to the inclusion of different growth determinants.

Our first estimation examines whether the exchange rate effect is significant despite accounting for the determinants of capital accumulation. In Table 2.1, regression (1) show that despite accounting for the educational attainment level of the population, and the gross capital formation, as proxies for human and physical capital investments, real exchange rate depreciations correlate significantly with lower productivity growth. Intuitively, according to our estimate, a 1% five-year average real exchange rate depreciation is expected to reduce productivity growth by nearly 0.2%[63].

[62] As described in the methodology section of this chapter, our estimations include a standard set of control regressors plus additional determinants of productivity growth. The standard set of control regressors remains constant across different estimations, while the inclusion of other growth determinants may vary according to the hypothesis being examined. Due to data availability, and to avoid the over-identification of the model, we do not include all the control regressors and growth determinants in a single estimation. Note that the standard set of control regressors includes the trade openness, the government consumption to GDP, the rate of inflation, and a measure for banking and currency crisis.

[63] Note that in our model the dependent variable is the growth rate of output per worker as proxy for productivity growth. This growth rate is expressed in percentage terms, that is, calculated by logarithmic differences and then multiplied by a 100. This transformation was done to simplify the exposition of the results.

Table 2.1
Real exchange rate effects on productivity growth in Latin America
Time horizon: 1980-2009, five-year averages
System generalized method of moments estimation

	(1)	(2)	(3)	(4)
Real bilateral exchange rate	-0.212*	-0.118*	-0.167*	-0.207**
	(0.118)	(0.0668)	(0.0930)	(0.0978)
Initial output per worker	-0.342	-1.765	-1.070	-1.642
	(1.091)	(1.485)	(1.749)	(2.209)
Investment	0.512	3.625		
	(2.718)	(3.187)		
Education	2.074	2.706	1.336	
	(2.056)	(2.434)	(3.312)	
Total imports of goods and services		-4.083**	-1.984	
		(1.894)	(2.644)	
Institutions			7.084	14.08*
			(6.251)	(6.936)
Savings				0.144
				(0.108)
External debt				-0.777
				(1.405)
Financial development				0.839
				(1.601)
Trade openness	0.737	4.739**	3.527	3.387
	(1.867)	(1.710)	(2.511)	(2.422)
Government consumption	-2.117	-0.0252	-1.742	-4.175
	(2.120)	(1.241)	(1.609)	(2.796)
Inflation	-1.816	-0.895	-1.772	-1.515
	(1.857)	(1.076)	(1.646)	(1.435)
Banking and currency crisis	-0.100	-1.031	-0.509	-1.724
	(3.128)	(2.883)	(4.112)	(2.716)
Constant	-3.056	-7.669	1.376	9.130
	(17.00)	(15.52)	(9.796)	(26.26)
Specification tests				
i) *F*-statistic	0.00	0.00	0.00	0.00
ii) Serial Correlation				
Arellano and Bond AR(2)	0.41	0.68	0.22	0.57
iii) Hansen *J* statistic for instruments validity	0.40	0.71	0.52	0.55
iv) Difference-in-Hansen Statistic				
Lagged growth instruments	0.71	0.94	0.68	1.00
All system GMM instruments	0.40	0.71	0.57	0.55
Observations	138	138	139	142
Number of groups	24	24	24	26
Instrument count	22	24	25	27

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the real exchange rate index (growth) measure currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). This table reports the t-test instead of the z-test, and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: the control regressors are assumed endogenous. Initial output per worker was assumed predetermined, using second lags in regression (1) and first lags in regression (2). Endogenous variables use second lags for the difference equation and first lags for the levels equation. Predetermined variables, in addition, are instrumented with first lags for the difference equation and contemporaneous lagged first differences as instruments for the level equation. These are standard choices given the covariates assumptions as the system chooses the closest appropriate lags (Roodman, 2009a). All the estimations include time period specific effects. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

Table 2.1 also examines the relationship between the real exchange rate, productivity and total imports of goods and services. Regression (2) confirms that the statistical significance of the real exchange rate coefficient is not sensitive to the inclusion of a measure for total imports[64]. Despite that the sign of the total imports coefficient is negative, this result may suggests that conditioning on real exchange rate depreciations, additional imports of goods and services may have a negative effect on domestic productivity growth. Without extending beyond the necessary in this topic, one can intuitively suggest that goods and services imports—except those devoted for production—may compete with domestically produced goods and services, reducing firm's profits, and hence possibly lessening the needs to innovate, thus resulting in lower productivity growth.

An important issue in productivity growth models is whether the variable of interest may be capturing the effects of the rule of law, patents and property rights on growth. In addition, one may argue that distortionary exchange rate policies may be the result of weak institutions that leads to macroeconomic instability (Acemoglu et al., 2003). Consequently, in regression (3) we address this issue and control for institutional development in these economies. Our findings show that the contractionary effects of real exchange rate depreciations are statistically significant despite accounting for institutions. In addition, our findings suggests that accounting for institutions and total imports may actually reinforce the exchange rate effect on productivity[65].

Finally, in regression (4) we control for the countries level of savings, external debt, and financial development[66]. Our results show that after controlling for institutions, savings, external debt, and financial development,

[64] Note here that the exchange rate coefficient is reduced to nearly a half in absolute terms when accounting specifically for total imports. This may be actually derived from the over accounting of total imports in the estimations. Recall that total imports have already been accounted for in the trade openness measure. Therefore, we are over-accounting for the imports effects by including specifically a measure for total imports when we have already included a measure for trade openness which includes both total exports and imports of goods and services as a proportion of GDP.

[65] It seems to be the case that weak institutions and the high dependency of these economies to imports is an important channel through which the contractionary effect of real exchange rate depreciations may operate.

[66] Financial development is measured as domestic credit to the private sector. Data proceeds from the World Development Indicators.

the contractionary effect of real exchange rate depreciations is negative and significant. Our findings suggests that the exchange rate effect on productivity is insensitive to the countries level of financial development.

Our results in terms of the exchange rate effect on productivity, while controlling for financial development, differs from those of Aghion et al. (2009) in three important directions. First, we suggest a linear relationship between financial development, the real exchange rate and productivity growth. Second, we examined the effects of changes in the real exchange rate on productivity growth. Third, we show that after controlling for institutions, savings and external debt, there is a limited role for financial development in explaining the growth effects of real exchange rate variations on productivity.

Our findings suggests that the benefits of a higher financial development are closely link to those of external debt in Latin America. However, our results can be reconcile with those of Aghion et al. (2009) if one is willing to assume that overall the Latin American economies are characterized by financial underdevelopment. In that order, the financial underdevelopment of these economies may be one of the main reason why this variable appears statistically insignificant in our estimations. However, our results may also be interpreted as suggesting that the financially underdeveloped economies of Latin America may benefit more from stable exchange rate values and stability in the foreign exchange markets.

The main empirical results presented in Table 2.1 indicate that the inclusion of additional growth determinants to account for any possible omitted variables may actually serve to reinforce the exchange rate effect on productivity. Possibly, these findings suggests that previous failures to properly address omitted variables and endogeneity bias were the drivers behind the lack of discovery of a contractionary effect of real exchange rate depreciations on productivity. A significant proportion of the literature has acknowledged that persistent real exchange rate depreciations are not a solution to enhance growth by promoting export growth and exports competitiveness, and in a variety of conditions and scenarios, currency depreciations or devaluations may actually inhibit economic growth and development[67].

[67] For a discussion see Krugman and Taylor (1978), Agénor (1991), Krugman (1994) and Ito et al. (1999). For a survey see Levy-Yeyati and Sturzenegger (2010).

Turning to the system GMM specification tests in Table 2.1, when all the available instruments are used in the estimation, this leads to an intentional over-identification of the model, meaning the system fails to properly identify and expunge the endogeneity bias due to instrument proliferation. In this case the exchange rate effect while negative is not significant. Once these instruments are properly reduced for following the Roodman (2009b) methodology, then a negative and significant real exchange rate effect on productivity appears.

The implementation of dynamic control specifications is adopted in Table 2.1. This implies that we use a standard set of control regressors plus additional determinants of productivity growth in order to observe how the coefficient of interests respond to different estimation specifications. According to the methodology described in Section 2.4, the growth determinants and control variables used in our estimations have proven to convey parameter stability. Even after controlling for economic policy and the main determinants of productivity such as savings, investment, human capital and institutional development, along with price stability measures, government consumption and a measure for banking and currency crisis, the exchange rate effect continued to be negative and statistically significant.

The real exchange rate effect on productivity appears to be a structural feature of the Latin American economies. The high dependency of these economies to imported capital and foreign technologies is argued to be an important explanatory channel through which the exchange rate effect on productivity may operate. Currency depreciations may increase the acquisition costs of key capital imports and intermediate inputs of production, thus leading to lower investments and capital accumulation (Krugman and Taylor, 1978, Agénor, 1991). In that order, by limiting the acquisition of foreign physical capital with possible embodied technologies, currency depreciations may inhibit productivity growth thereby reducing the prospects of economic growth and development. Consequently, persistent currency depreciations cannot be in line with a sustainable trend towards a higher economic development (Ito et al., 1999).

Another important channel through which the contractionary effect of real exchange rate depreciations may operate is that of the balance sheet channel (Hausmann et al., 2001, Hausmann and Panizza, 2003). In that order, currency mismatches and a high degree of foreign currency liabilities may lead central banks to hold larger amounts of international reserves and allow less variability in the real exchange rate. In addition, currency mismatches in the balance sheets of the governments and the firms may lead to investments and credit restrictions that may have a negative effect on capital accumulation, productivity and growth[68].

2.5.2 Real exchange rate volatility and productivity

The next question we now address is whether the volatility of the real exchange rate have a negative effect on productivity growth in Latin America. Recent empirical evidence have suggested that real exchange rate volatility may affect the profits of credit-constrained firms thereby inhibiting investments and innovation, with the corresponding negative consequences on productivity growth. (Aghion et al., 2009). However, in many instances, the contractionary effects of real exchange rate volatility crucially depends on the countries levels of financial development. In this chapter, we aim to generalize and extend the hypothesis on the contractionary effects of real exchange rate volatility. To quantify these effect, we estimate Eq. (2.3) substituting the exchange rate measure for an index of real exchange rate volatility[69].

[68] The balance sheet effects of currency depreciations are highly present in Latin America as governments and firms in the region hold large amounts of debts and deposits denominated in U.S. dollars (Mishkin and Savastano, 2001, Rennhack and Nozaki, 2006). Under this conditions, flexible exchange rates with persistent currency depreciation may increase the debt service, have adverse wealth-effects, and induce a financial crisis due to currency mismatches.

[69] The real exchange rate volatility measure is defined as the standard deviation of the annual logarithmic differences of the real bilateral exchange rate index during each five-year interval.

Table 2.2
Real exchange rate volatility and productivity growth in Latin America
Time horizon: 1980-2009, five-year averages
System generalized method of moments estimation

	(1)	(2)	(3)	(4)
Real bilateral exchange rate	-0.223*		-0.210**	
	(0.111)		(0.0906)	
Real bilateral exchange rate volatility		-0.237		-0.235*
		(0.248)		(0.134)
Initial output per worker	-0.0861	-1.841	-0.889	-0.242
	(2.434)	(3.670)	(1.779)	(2.027)
Financial development	0.146	2.590	0.224	-0.492
	(1.029)	(1.674)	(0.996)	(1.187)
Institutions	2.749	2.125		
	(4.775)	(10.43)		
Terms of trade	0.118	0.274		
	(0.114)	(0.225)		
Education			0.585	0.901
			(3.368)	(3.427)
Terms of trade volatility			-0.0607	-0.0966
			(0.0386)	(0.0677)
Trade openness	1.517	-2.004	0.915	1.283
	(1.204)	(2.940)	(1.056)	(3.516)
Government consumption	-1.750	5.183	-1.471	-0.206
	(2.022)	(3.114)	(1.838)	(3.064)
Inflation	-0.777	1.417	-1.612	-2.819
	(1.178)	(1.776)	(1.615)	(1.651)
Banking and currency crisis	-0.405	-5.220	1.604	9.445
	(3.055)	(5.713)	(3.905)	(6.099)
Constant	-5.070	-0.644	5.829	-4.927
	(21.85)	(32.06)	(16.29)	(24.56)
Specification tests				
i) F-statistic	0.00	0.00	0.00	0.00
ii) Serial Correlation				
Arellano and Bond AR(2)	0.42	0.66	0.68	0.19
iii) Hansen J statistic for instruments validity	0.35	0.24	0.55	0.88
iv) Difference-in-Hansen Statistic				
Lagged growth instruments	0.40	0.37	1.00	0.82
All system GMM instruments	0.35	0.24	0.88	0.39
Observations	129	129	124	124
Number of groups	23	23	22	22
Instrument count	23	23	24	24

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the real exchange rate index (growth) measure currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). This table reports the t-test instead of the z-test, and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: the control regressors are assumed as endogenous, except the terms of trade which are assumed exogenous. Initial output per worker was assumed predetermined, using second lags in regression (1) and (2). Endogenous variables are instrumented using second lags for the difference equation and first lags for the levels equation. Predetermined variables, in addition, are instrumented with first lags for the difference equations and contemporaneous lagged first differences as instruments for the level equations. All the estimations include time period specific effects. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

Table 2.2 report the estimation results on real exchange rate volatility and productivity growth in Latin America. Our preliminary estimates suggests that institutions in Latin America matter relatively more for productivity than financial development. Intuitively, this relationship may simply imply that countries that have been characterized by high degrees of exchange rate uncertainty and volatility are often associated with weak institutions. In that order, our results show that there is a negative correlation between real exchange rate volatility and productivity growth despite accounting for financial development in these economies. Moreover, our findings suggests that exchange rate volatility may have significant detrimental effects on productivity in financially underdeveloped countries exposed to a high variability in the terms of trade. When we account for the educational attainment level of the population, and the volatility of the terms of trade, we find a negative and statistically significant growth effect of real exchange rate volatility on productivity.

Our results on exchange rate volatility extend those of Aghion et al. (2009) with two important differences: first, we find that institutional development is as important as financial development in explaining productivity variations caused by excessive movements in the real exchange rate. In that order, the contractionary effects of real exchange rate volatility are reinforced in countries with weak institutions and less developed financial systems. Second, our results indicate a linear negative correlation between exchange rate volatility and productivity growth, and the effect does not crucially depends on the countries levels of financial development. The high dollarization and currency mismatches in governments and firms balance sheets is an important channel through which the contractionary effects of real exchange rate volatility on economic growth and productivity may operate. Overall, we conclude that real exchange rate volatility have a negative and an in many instances significant effect on productivity growth in Latin America.

2.5.3 Exchange rate misalignments and productivity

In what follows, we address the following question: Do real exchange rate misalignments drives a faster productivity growth? To answer this question we construct a variety of misalignment measures that are comparable across countries and across different time windows for each Latin American country. As we discussed in the data section, two measures of real exchange rate misalignment were constructed for each economy following the methodologies proposed by Rodrik (2008) and Goldfajn and Valdes (1999)[70].

Following the Rodrik (2008) methodology, real exchange rates were calculated for each economy using the nominal exchange rate and the purchasing power parity from the Penn World Tables. Then, equilibrium real exchange rates adjusted by Balassa-Samuelson effects were estimated for each economy by regressing the real exchange rate on real GDP per capita, from which follows that an undervaluation index can be defined as the logarithmic deviation of the real exchange rate from its adjusted equilibrium value[71]. This methodology is fairly similar to the one proposed by Johnson et al. (2007). The procedure has the advantage that it produces misalignment data for the full sample of thirty-two economies in the region across the time span of the data.

Our second alternative measure for misalignment is an undervaluation series calculated following a modified version of the Goldfajn and Valdes (1999) methodology. Following this methodology, we control for stochastic trends in the real bilateral exchange rate index by applying the Hodrick–Prescott (HP) filter (Hodrick and Prescott, 1997) . The filtered series denotes the equilibrium real exchange rate, and the misalignment—as a cyclical component—defines the deviation of the real exchange rate from its equilibrium trend[72].

The original Goldfajn and Valdez methodology was modified to incorporate the Ravn and Uhlig (2002) frequency power rule for the HP filter. In addition, we extended the definition of currency misalignment as to consider any deviation of the real exchange rate from its equilibrium value as a form of misalignment rather than a deviation above a specific threshold. This methodology was implemented because it allows the equilibrium exchange

---

[70] Note that under these methodologies the currency will be undervalued or depreciated if its value is above the equilibrium exchange rate, and will be overvalued if it is below the equilibrium. This dynamics are consistent with a definition of the real exchange rates in national currency per US dollar.

[71] See Obstfeld and Rogoff (1996) for a discussion over the Balassa-Samuelson effect.

[72] See the appendix A.6 on the definitions and sources of the variables for additional details on how these misalignment measures were constructed.

rate to time-vary endogenously with the data generating process, and use a more appropriate smoothing parameter for annual frequencies. In addition, this methodology produce estimates readily available for all the countries in the sample, and is not restricted or limited by data availability. We refrain from estimating misalignment measure using country-specific macro-simulated models due to data limitations for Latin America.

Table 2.3 presents the results on real exchange rate misalignments and productivity growth in Latin America. Our findings show that real exchange rate misalignments have a contractionary effect on productivity growth in the current period, although the effect is found to be statistically insignificant. In order to capture the potential long run growth effects of currency misalignments, we incorporate explicitly lagged values of the undervaluation index up to the first period lag[73]. Estimation (3) in Table 2.3 reports an insignificant growth effect of lagged currency misalignments on productivity. This result can be interpreted as suggesting possible nonlinearities in the relationship between currency misalignments and productivity. However, during the system GMM estimations, a variety of interaction terms and non-linear hypothesis were tested, and these resulted to be statistically insignificant[74]. These findings implies that—given our system GMM procedure—the potential growth effects of lagged currency misalignments turn out to be insignificant once we control for the endogeneity of the productivity growth determinants.

Using an alternative specification for currency misalignments, that is an undervaluation series calculated using the modified Goldfajn and Valdes (1999) methodology, Estimation (4) in Table 2.3 bring additional supporting evidence to the view that once we control for endogeneity bias there are negative but insignificant growth effects of currency misalignments on productivity[75].

---

[73] Recall that the system GMM procedure uses lagged levels of the variables, and lagged first differences of these, as instruments for the first difference equations and the levels equations, respectively. This is the major reason why we do not incorporate additional lagged levels of currency misalignments as regressors in our estimations. Moreover, once we incorporate additional lagged levels of currency misalignments the estimated coefficient of these resulted to be negative and insignificant.

[74] These additional tests are available from the author upon request.

[75] Using lagged levels of the undervaluation series do not change the qualitative results of this chapter.

Table 2.3
Real exchange rate misalignments and productivity growth in Latin America
Time horizon: 1980-2009, five-year averages
System generalized method of moments estimation

	(1)	(2)	(3)	(4)
Real bilateral exchange rate	-0.167*			
	(0.0930)			
Real exchange rate misalignments				
Undervaluation index		-0.166		
		(2.042)		
Undervaluation index: lagged one period			1.309	
			(2.551)	
Undervaluation series				-6.245
				(25.64)
Initial output per worker	-1.070	-0.206	-0.900	-0.347
	(1.749)	(1.856)	(1.532)	(3.617)
Institutions	7.084	4.088	3.316	5.842
	(6.251)	(3.479)	(3.385)	(7.096)
Education	1.336	-1.489	-0.0782	-0.170
	(3.312)	(2.548)	(2.639)	(5.430)
Total imports of goods and services	-1.984	-1.723	-0.619	-2.481
	(2.644)	(2.754)	(3.514)	(2.404)
Trade openness	3.527	1.567	1.608	2.813
	(2.511)	(3.155)	(4.176)	(4.806)
Government consumption	-1.742	-0.836	1.838	-1.568
	(1.609)	(2.153)	(2.519)	(1.575)
Inflation	-1.772	-1.007	4.392	-1.542
	(1.646)	(1.418)	(7.361)	(1.596)
Banking and currency crisis	-0.509	-4.899	-2.906	-2.093
	(4.112)	(2.863)	(4.942)	(9.818)
Constant	1.376	7.093	0.119	32.01
	(9.796)	(10.04)	(10.11)	(115.6)
Specification tests				
i) F-statistic	0.00	0.00	0.00	0.00
ii) Serial Correlation				
Arellano and Bond AR(2)	0.22	0.57	0.72	0.74
iii) Hansen J statistic for instruments validity	0.52	0.62	0.84	0.34
iv) Difference-in-Hansen Statistic				
Lagged growth instruments	0.68	0.35	0.95	0.74
All system GMM instruments	0.57	0.58	0.80	0.34
Observations	139	134	111	139
Number of groups	24	24	24	24
Instrument count	25	25	24	25

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the real exchange rate index (growth) and in the undervaluation index/series measure currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). This table reports the t-test instead of the z-test, and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: the control regressors are assumed endogenous. Initial output per worker was assumed predetermined. The endogenous variables are instrumented using second lags for the difference equation and first lags for the levels equation. Predetermined variables, in addition, are instrumented with first lags for the difference equations and contemporaneous lagged first differences as instruments for the level equations. All the estimations include time period specific effects. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

A plausible reason for why currency misalignment's have a negative effect on productivity growth in Latin America is that these economies relies heavily on imported inputs to produce the goods and services that are exported. Therefore, while an undervaluation may initially boost exports growth by lowering their international relative prices, they may shrink export profits by raising imported input costs, and consequently exports and output growth may be limited in the event of an undervaluation.

The undervaluation and depreciation of the exchange rate may increase the costs of imports thereby restricting the acquisition of imported capital and intermediate inputs of production with embodied technologies. Given these conditions, the technological change embodied in capital accumulation is limited, with the corresponding negative consequences for productivity growth.

The fact that the production process of export goods relies heavily on imported inputs finds strong support in the existing literature. For example, Hummels et al. (2001) documents important changes in the pattern of international trade where since the 1970's several advanced and emerging market economies have increased their share of export goods produced with a high content of imported inputs.

While there have been several studies examining the links between currency misalignment and economic growth, studies examining the relationship between misalignment and productivity are scarce[76]. The results of our chapter aim to fill this gap in the existing literature, as we have examined the growth effects of currency misalignments on productivity growth in Latin America once we have controlled for the endogeneity bias of the determinants of productivity.

In a recent study about the potential threshold effects of currency misalignments on economic growth, Couharde and Sallenave (2013) finds significant evidence indicating that currency misalignments up to a 7% may enhances economic growth in emerging market economies[77]. For the case of Latin America, our results in Table 2.3, regression (2) and (3), suggests a

[76] See, for example, the recent survey conducted by Levy-Yeyati and Sturzenegger (2010) in relation to the empirical and theoretical evidence on exchange rate policies.

[77] In their total sample of countries, the estimated misalignment threshold to boost economic growth is 18.69%; while for the Asian economies is approximately 26% (Couharde and Sallenave, 2013).

13.5% inter-period threshold effect of currency misalignments on productivity growth[78]. Our informal estimate is surprisingly close to the 7% threshold proposed by Couharde and Sallenave (2013) for their sample of emerging market economies. However, our estimate is relatively higher, and the growth and threshold effects of currency misalignments are mostly found to be statistically insignificant in our estimations.

According to our findings, there are no long run growth effects of currency misalignments on productivity. Our results show that these growth effects are statistically insignificant for productivity, and on average mostly negative, particularly at the current period. In a study on exchange rates and economic development in Latin America, Gala (2008) argues that, on the contrary, overvaluations have contributed to a variety of crisis, macroeconomic imbalances, and slow growth performance in the region. In that order, Gala (2008) supports the view that undervaluations may be an instrument to enhance investment-led and export-led growth. However, our results for the thirty-two Latin American economies indicates that undervaluations and persistent currency depreciations are not either a solution to enhance economic growth in the region, particularly after considering the Prebisch-Singer theory and the high dependency of these economies to imported capital and foreign technologies.

Persistent real exchange rate depreciations and currency misalignments are suggested to have a negative impact on long term economic growth and development performance through its potential contractionary effect on productivity growth. The results of this chapter supports the view of Couharde and Sallenave (2013) that countries should not base their development strategies on currency misalignments. As in Gala (2008), on the other hand, our results indicate that persistent overvaluations are not either the solution, especially if these economies aim at outward development and

---

[78] Informally, we reach this number by defining the threshold level as the coefficients ratio of the inter-period undervaluation index, that is:

$$\widehat{r_{l,t}} = 1 - \left\{\exp(-\tfrac{(-0.166)}{1.309}\right\}.$$

See, for example, Aghion et al. (2009) for a more rigorous approach to calculate exchange rate threshold effects on empirical growth models using system GMM. The reason why do not pursue further the Aghion et al. (2009) approach is that our estimates for currency misalignments are statistically insignificant once we adopt the endogeneity assumption, therefore these coefficients are not statistically different than zero.

export-led growth. What our results indicate is the superior growth enhancing effect of real exchange rate stability. In that order, Eichengreen (2008) have also suggested that the negative growth effects of exchange rate variations have dominated when countries move towards higher levels of economic development. Therefore, as in Eichengreen (2008), we also call for real exchange rate stability as being beneficial not only for productivity growth, but also for output growth and economic development.

The evidence presented in Table 2.3 also indicates that while a one-step undervaluation (lagged one period) may be growth enhancing in the spirit of Rodrik (2008) and Razmi et al. (2012), successive currency depreciations have a negative effect on productivity. A possible explanation for this results is that currency misalignments are normally driven by stages of crisis build-ups, as countries normally lack the ability to sustain the misalignment over long time horizon[79]. As a consequence, the maintenance of the currency misalignments normally ends up in important output collapses and declines in productivity.

2.5.4 Exchange rate regimes and productivity

We now examine the relationship between exchange rate regimes and productivity growth. Accounting for exchange rate regimes in the estimations allow us to control for the growth effects of variations in the nominal exchange rate arrangements, and the economic policies associated with these regimes. For this aim, we estimate Eq. (2.3) substituting the exchange rate measure for alternative specifications of nominal exchange rate regimes, following the data methodology described in Section 2.4.

Table 2.4 presents the estimation results on exchange rates regimes and productivity growth in thirty-two Latin American economies over the period from 1980 to 2009. Our results shows that additional flexibility in the exchange rate regime conventionally leads to a negative but insignificant growth effects on productivity. In other words, we do not find significant evidence indicating that variations in the nominal exchange rate arrangements leads to significant changes in productivity growth.

[79] By long horizons we refer to a time period of 25 years or more (Solow, 2005).

Table 2.4
Exchange rate regimes and productivity growth in Latin America
Time horizon: 1980-2009, five-year averages
System generalized method of moments estimation

	(1)	(2)	(3)	(4)
Real bilateral exchange rate	-0.235**			
	(0.107)			
Exchange rate regimes classifications				
Natural classification		-0.257		
		(1.002)		
De facto classification			0.156	
			(0.791)	
IMF de jure classification				-0.311
				(0.420)
Initial output per worker	-0.844	-0.0433	-1.240	-1.613
	(0.862)	(1.567)	(1.227)	(1.931)
Education	3.533**	1.969	0.594	1.487
	(1.358)	(1.813)	(1.639)	(3.375)
Investment	3.385	5.047	3.110	2.698
	(3.449)	(3.103)	(1.905)	(3.091)
Total imports of goods and services	-2.581	-2.719	-2.508	-2.138
	(2.105)	(2.113)	(1.724)	(3.143)
Trade openness	1.773	1.867	1.764	2.452
	(2.841)	(3.826)	(2.763)	(5.554)
Government consumption	-0.119	-0.492	-0.671	-0.811
	(1.431)	(1.425)	(1.256)	(1.711)
Inflation	-1.997**	-0.563	-0.809	-1.393
	(0.940)	(0.730)	(0.577)	(0.990)
Banking and currency crisis	-0.537	-1.426	-2.953	-0.550
	(2.069)	(3.879)	(2.692)	(3.484)
Constant	-11.52	-18.75	3.396	1.712
	(15.91)	(12.76)	(13.52)	(31.93)
Specification tests				
i) F-statistic	0.00	0.00	0.00	0.00
ii) Serial Correlation				
Arellano and Bond AR(2)	0.44	0.43	0.79	0.13
iii) Hansen J statistic for instruments validity	0.87	0.74	0.77	0.46
iv) Difference-in-Hansen Statistic				
Lagged growth instruments	0.49	0.34	0.78	1.00
All system GMM instruments	0.87	0.74	0.77	0.46
Observations	138	140	116	130
Number of groups	24	24	24	24
Instrument count	23	23	22	23

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the exchange rate regime *de facto* classification resemble currency apreciations, while additional flexibility in the *natural* and the *de jure* regime classifications measure nominal currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). This table reports the t-test instead of the z-test, and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: the control regressors are assumed endogenous, except for the crisis control which is assumed a predetermined. Initial output per worker was also assumed predetermined, using second lags as instruments. The endogenous variables use second lags for the difference equation and first lags for the levels equation. All the estimations include time period specific effects. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

The coefficient estimates are stable across a variety of alternative exchange rate regimes classifications, which may serve as a robustness checks for our results. In addition, the coefficient estimates reflects the property of stable sign reversal under alternative definitions for nominal exchange rate arrangements[80]. According to the natural exchange rate regime classification proposed by Ilzetzki et al. (2008), our results suggests that higher degrees of float correlates with lower productivity growth in the region. The value of the estimated coefficient is relatively close to the growth effect predicted by real exchange rate depreciations, namely that higher regime flexibility towards a currency depreciation leads to a reduction in productivity growth of approximately 0.25%.

Despite that we do not find significant evidence indicating that variations in the nominal exchange rate arrangements leads to significant changes in productivity, it seems important to discuss the correlations between the alternative definitions of nominal exchange rate arrangements and productivity growth. In that order, while using the IMF de jure classification, our findings indicate that higher regime flexibility correlates with lower productivity. In addition, the results from the Levy-Yeyati and Sturzenegger (2005) de facto classification also show that fixed exchange rate arrangements may correlate with higher productivity growth.

Overall, our results show that variations in the nominal exchange rate regime leads to insignificant changes in productivity. In that order, our findings extend and bring support to the exchange rate regime neutrality hypothesis initially proposed by Baxter and Stockman (1989)[81]. However, our findings suggests that flexible exchange rate arrangements do correlate with lower productivity growth in the region.

Potential explanations for our result on the neutrality of nominal exchange rate regimes on productivity are as follow. First, the vast majority of these economies have conventionally operated in a framework of intermediate regimes, nor completely flexible, nor completely fixed with few important

[80] In Table 2.3, see regression (3) where currency depreciations in the de facto exchange rate regime classification are defined as decreases in the exchange rate index.

[81] Although they do not consider specifically productivity growth, Baxter and Stockman (1989) suggests that changes in the exchange rate arrangements have a neutral effect on macroeconomic aggregates and international trade.

changes over time[82]. Second, the significance of the exchange rate regime coefficient may also be related to the definition of the exchange rate regime, and to the fact that the pattern of floating may actually differs from the one predicted by the exchange rate regime in place.

The determination of how the exchange rate regimes should be defined by nominal or real exchange rate movements is also important, and is still an issue of intensive dispute in the existing literature[83]. Conventionally, nominal exchange rate regimes are defined by nominal exchange rate variations. On the contrary, the real exchange rate measure takes into consideration variations in the international relative prices among countries, as well as changes in the nominal exchange rate. In that order, the behaviour of the real exchange rate may actually differs from that predicted by the nominal exchange rate regime in place, with corresponding consequences for productivity[84].

A potential operating channel through which flexible exchange rate regimes may have a negative growth effect on productivity is by the high levels of foreign currency denominated debt and currency mismatches that characterizes governments and firms balance sheets in the Latin American economies. In that order, additional flexibility in the exchange rate regime may lead to persistent currency depreciations which could have negative balance sheet effects (Hausmann et al., 2001, Hausmann and Panizza, 2003). These issues may be one of the main reasons for the fear of floating in Latin America, as most of these economies have historically operated under fixed to

---

[82] See, for example, Ilzetzki et al. (2008) and Levy-Yeyati and Sturzenegger (2005).

[83] Note that that there are classifications for nominal exchange rate regimes, while classifications for real exchange rate arrangements are very scarce. For a discussion see Levy-Yeyati and Sturzenegger (2010).

[84] The statement that the evolution of the real exchange rate replicate variations in the nominal exchange rate, and changes in the exchange rate regime, is less likely to hold given the high discrepancies in inflation performance in these economies during the last decades. In that order, the differences in inflation performance may lead to deviations of the nominal from the real exchange rate, and such deviations could crucially depends on how responsive nontradable prices are to nominal exchange rate movements. These conclusions by no means suggest that we should disregard the importance of exchange rate regimes in understanding the evolution of the real exchange rate. It may just reflect the issue that perhaps a broader definition of exchange rate regimes is needed in a way that accounts not only for domestic currency valuations, but also for domestic and international price differences.

intermediate exchange rate arrangements (Calvo and Reinhart, 2002, Frenkel and Rapetti, 2010)[85].

Despite our results show that the choice of the nominal exchange rate regime have a neutral effect on productivity, we are not suggesting that the adoption of the exchange rate regime does not have any meaningful impact on long run productivity growth. Our results supports that view that if floating implies an excessive and persistent trend towards currency depreciations, this will inhibit productivity growth. The negative growth effects could either operate via the negative balance sheet effects, or by increasing the costs of acquiring capital imports which may further limit capital accumulation and technological change. In that order, we ascribe to the view that stable—fixed to intermediate—exchange rate arrangements may benefit more the developing economies of Latin America.

2.5.5 Robustness checks

We perform a series of estimations under different econometric methods, alternative specifications, additional explanatory variables, and different instrument count. Table 2.5 presents the estimation results under different econometric methodologies. The first regression implements the system GMM estimation following the Arellano and Bover (1995) forward orthogonal deviation transformation[86]. In accordance with our previous findings, our results with the forward orthogonal deviation method also show there is a significant negative effect of real exchange rate depreciations on productivity growth[87].

[85] The inclusion of a measure for financial development in our estimations does not change the qualitative results presented in this chapter. However, as in Aghion et al. (2009), our findings do suggests that the financially underdeveloped economies of Latin America may benefit more from fixed to intermediate exchange rate arrangements.

[86] Under forward orthogonal deviations, the first difference transformation subtract current values of the variables from the average of future observations, instead of the traditional transformations in which current values are subtracted from previous observations.

[87] Our findings bring additional empirical support to Arellano and Bover (1995) claim that when the estimator is optimal, the forward orthogonal deviation transformation yields similar results to the standard system GMM estimation

Table 2.5
Real exchange rate effects on productivity growth in Latin America
Robustness: econometric methodology
Time Horizon: 1980-2009, five-year averages

	System GMM: forward orthogonal deviations	Pooled ordinary least-squares estimator	Within-groups estimator
	(1)	(2)	(3)
Real bilateral exchange rate	-0.366**	-0.0658*	-0.0638**
	(0.163)	(0.0396)	(0.0290)
Initial output per worker	-0.872	-1.097**	-8.048***
	(2.313)	(0.541)	(1.073)
Institutions	16.38***	2.053	3.889**
	(5.814)	(1.345)	(1.450)
Savings	0.160	0.0436*	0.0568
	(0.1000)	(0.0246)	(0.0411)
External debt	0.597	-0.870**	-0.893
	(0.918)	(0.393)	(0.523)
Financial development	0.720	0.550	-0.460
	(1.469)	(0.415)	(0.660)
Trade openness	3.663	0.393	-0.584
	(2.271)	(0.504)	(1.473)
Government consumption	-2.585	0.213	-2.861**
	(1.856)	(0.659)	(1.280)
Inflation	-2.494*	-1.650***	-1.656***
	(1.343)	(0.485)	(0.592)
Banking and currency crisis	-1.836	-1.020	0.505
	(2.338)	(0.935)	(0.806)
Time effects	Yes	Yes	Yes
Country specific effects	Yes	No	Yes
Constant	-8.305	8.172	88.55***
	(23.17)	(5.451)	(13.30)
Specification tests			
i) F-statistic	0.00	0.00	0.00
ii) Adjusted R-squared		0.29	0.52
iii) Hansen J statistic for instruments validity	0.38		
Observations	142	142	142
Number of groups	26	26	26
Instrument count	27		

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the real exchange rate index (growth) measure currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). GMM instrumentation: control regressors are assumed endogenous. Initial output per worker was assumed predetermined. The endogenous variables are instrumented with second lags for the difference equation and first lags for the levels equation. Predetermined variables, in addition, are instrumented with first lags for the difference equation and contemporaneous lagged first differences as instruments for the level equation. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

The imposition of the exogeneity assumption to the explanatory variables do not change the qualitative results of our empirical growth model. In Table 2.5, regressions (2) and (3), report the estimation results of Eq. (2.3) with the pooled ordinary least-squares and the within-groups estimator. Using both estimation methods, we find significant evidence in favour of a contractionary effect of real exchange rate depreciations on productivity. Our results are invariant to the choice of econometric methodology, however our preferred estimation procedure is the standard system GMM estimation since it alleviate the potential bias that could be caused by simultaneity, omitted variables bias and measurement error (Bond et al., 2001).

Additional robustness checks implemented for our model are presented in Appendix B. In that order, Table B.1 summarizes the estimation results using alternative specifications for the real exchange rate measure. The first set of results presented in Table B.1 considers the real exchange rate based on wholesale price indexes (WPI) and producer price indexes (PPI). The motivation to introduce these definitions is to alleviate the potential influence that nontradable prices may exert in the real exchange rate measure constructed using consumer price indexes. In addition, our robustness checks also includes a real exchange rate index adjusted by purchasing power parity, and a measure for real effective exchange rates that is compiled by the International Monetary Fund (2012b) and use a basket of currency values and trade weights[88].

The estimated coefficients for the real exchange rate measures presented in Table B.1 are stable with the property of sign reversal. Intuitively, a sing reversal can be explained as follow: when an alternative definition has been used—for example, when increases in the exchange rate index denotes currency appreciations rather than depreciations—a relatively similar coefficient value is obtained with the opposite sign. The estimation results under each of these alternative specifications for the real exchange rate show a negative and statistically significant real exchange rate effect on

[88] By construction, as oppose to the bilateral measure, increases in the real effective exchange rate index denotes currency appreciations.

productivity. The choice of real exchange rate definition does not change the qualitative conclusions of our results[89].

The results presented in this chapter suggests that real exchange rate appreciations correlate with higher productivity growth, and that productivity growth may lead to currency appreciations[90]. This finding is consistent with the Harrod-Balassa-Samuelson hypothesis, namely that countries which have experienced sustainable increases in productivity have also tend to experience currency appreciation episodes[91].

It is important to note that the real effective exchange rate index was found to be insignificant across different estimations. A tentative explanation for this result may be the one proposed by Ellis (2001) who argues that fluctuations in the effective rate are sensible to the weights assigned to each foreign currency in the construction of the currency basket, as well as to large swings in the value of particular currencies. For example, Ellis (2001) provides evidence for the case of the real effective Australian dollar which during the Asian crisis was largely influenced by sharp movements in the currency values of the Asian countries experiencing the crisis. Because the swings of such currencies were so dramatic, even though they had a relatively low weight in the basket composition, feedbacks to the overall real effective exchange rate index were realized. In that order, under these cases fluctuations in the effective rate were not reflecting the true overall currency values position of the Australian dollar against all its trading partners[92].

Appendix B, Table B.2, presents the robustness checks to different control set specifications and instrument count. Regressions (1) and (2) indicate that controlling for growth and volatility in the terms of trade does not change the

---

[89] Due to availability in the data provided by Heston et al. (2011) and the International Financial Statistics (IFS), which are used to construct the different real exchange rates variables, the productivity growth models estimated in regressions (4) and (5) (Table B.1) includes less control variables than the traditional ones selected for fiscal policy, monetary policy, trade openness, and banking and currency crisis.

[90] Recall the estimations allows for simultaneity or endogeneity between these variables.

[91] For a discussion see Obstfeld and Rogoff (1996).

[92] This example suggests that using effective rates may expose the estimation to the influences that individual currency values may exert in the overall evolution of the real effective exchange rate.

qualitative results of this chapter[93]. In regression (3) we incorporate a new measure to account for financial development, that is, an emerging market dummy constructed to distinguish between emerging markets and developing countries[94]. Our findings show that higher financial development may lead to improvements in productivity, being the effect statistically insignificant. However, we find that real exchange rate depreciations are significantly correlated with lower productivity growth despite accounting for financial development in Latin America. In addition to these robustness checks, a variety of non-linear hypothesis and interaction terms were also tested across all these specifications, thus confirming our initial results on the contractionary effect of real exchange rate depreciations on productivity growth[95].

2.6 Conclusions

In this chapter we present evidence on the growth effects of real exchange rate variations, currency misalignments and nominal exchange rate regimes on productivity growth in thirty-two Latin American economies over the last thirty years from 1980 to 2009. The results presented in this chapter show that real exchange rate depreciations have a contractionary effect in productivity growth. In particular, if variations in the exchange rate are characterized by systematic exchange rate depreciations.

[93] Following Levy-Yeyati et al. (2010), the terms of trade for the Latin American economies are defined as exports as a capacity to import. Data proceeds from the World Development Indicators. Growth rates are calculated by logarithmic differences, and the volatility is defined as the standard deviation of annual log differences. See Section 2.4 and Appendix A.6 for additional details on the methodologies and definitions.

[94] The emerging market dummy is a proxy for financial development that denote countries that were classified as emerging markets in the EMBI Global Index, FTSE Global Equity Index, FTSE Emerging Market Index, or belong to the emerging market group according to the International Monetary Fund. This dummy variable takes the discrete value of one on the first year when the country was included in any of the indexes. It takes the value of zero otherwise, hence representing a developing country. This methodology draws on the classifications proposed by Husain et al. (2005) and Levy-Yeyati et al. (2010).

[95] These are not show for ease of exposition, however are available from the author upon request.

Our findings show that real exchange rate volatility exert a negative and significant effect on productivity growth. Currency misalignments—in particular undervaluations—are found to be negatively correlated with productivity. However, the growth effects of currency misalignments are reported to be statistically insignificant. Our evidence indicate that currency misalignments does not significantly explain productivity growth variations in Latin America.

The results presented in this paper also show evidence on the neutrality of nominal exchange rate regimes in explaining productivity. Our findings show that differences in productivity growth are not systematically related to differences in the nominal exchange rate regimes. However, we do find evidence indicating that flexible exchange rate arrangements that are characterized by currency depreciations may inhibit productivity growth. In addition, our evidence also suggests that variations in the real exchange rate are better predictors for growth than currency misalignments and nominal exchange rate regimes.

The dependency of the Latin American economies to imported capital and foreign technologies is argued to be an important channel through which the contractionary real exchange rate effect on productivity may operate[96]. By increasing the acquisition costs of imported capital with embodied technologies, real exchange rate depreciations may limit the technological change embodied in capital accumulation with the corresponding negative effects for productivity growth. In that order, our findings support the Prebisch (1950, 1959) and Singer (1950) theory for uneven development due to technological disparities in Latin America[97].

Our findings are in line with those that propose a contractionary effect of currency devaluations on economic growth through the increase in the acquisition costs of imported intermediate inputs of production (Krugman and Taylor, 1978, Lizondo and Montiel, 1989, Agénor, 1991). In that order, exchange rate devaluation episodes may not enhance export-led growth,

[96] This dependency to imported capital and foreign technologies is primarily caused by a lack of domestic innovation and research in new technologies, in addition to weak institutions that are not conducive to the maintenance of the rule of law and the protection of property rights (Bruton, 1967, North, 1989, Acemoglu et al., 2003).

[97] These technological disparities are argued to be reinforced by distortionary exchange rate policies that leads to persistent real exchange rate depreciations.

particularly if the goods and services that are exported are produced with a high content of imported inputs[98]. It will induce a contractionary effect on output, and as our findings show on productivity, by increasing the cost of acquiring imported capital and intermediate inputs of production; thereby limiting the technological change embodied in capital accumulation[99]. In that order, the evidence presented in this chapter indicate that the majority of the Latin American economies have been characterized by a high share of total goods and services imports over GDP, a negative correlation between currency depreciations and export growth, and an overall current account balance that have been traditionally negative thus reflecting the imports dependency[100].

Our results on the potential neutrality of nominal exchange rate regimes in explaining productivity extend those of Baxter and Stockman (1989). However, a key difference with our results is that we examined specifically the role of currency misalignments and nominal exchange rate regimes on productivity growth in the developing economies of Latin America. Nevertheless, our findings suggests that additional flexibility in exchange rate regimes and currency undervaluations are negatively correlated with productivity growth, particularly if there is a trend towards exchange rate depreciations. In that order, as in Husain et al. (2005) and Aghion et al. (2009), our findings support the view that the financially underdeveloped economies of Latin America may benefit more from fixed to intermediate exchange rate arrangements that brings exchange rate stability around its equilibrium value.

According to our findings, as opposed to Gala (2008), Razmi et al. (2012) and Rodrik (2008), we do not ascribe to the view that currency undervaluations may enhance neither growth nor development in Latin America. In particular, after considering the historical dependency of these economies to imported capital and foreign technologies. We neither suggest

---

[98] In this issue, Hummels et al. (2001) document important evidence indicating that since the 1970's several advanced and emerging market economies have increase the share of imported inputs used in the production of export goods. This process has been defined as vertical specialization. Our findings support the view that vertical specialization is highly present in Latin America.

[99] See Hercowitz (1998) for an interesting discussion on the embodiment controversy.

[100] See Figures 2.1 through Figure 2.6.

that overvaluations are the proposed solution for growth. According to our findings, as in Eichengreen (2008), we call for exchange rate stability.

Unlike previous studies in the existing literature, we are the first to carry out a comprehensive examination of exchange rates and productivity growth in the thirty-two Latin America economies over a period of thirty years. We use modern dynamic panel data estimation procedures that corrects for the potential endogeneity of the growth determinants in a dynamic setting. The main findings of this paper are robust to changes in the econometric methodology, alternative specifications, non-linear hypothesis, outlier's sensitivity, unobserved heterogeneity, and other robustness checks.

Some caution for the economic policy agenda of Latin America needs to be stated here. Our findings by no means suggest the re-establishment of fixed exchange rate arrangements. There are key differences between real and nominal exchange rates, and the evolution of the real exchange rate may not be the one predicted by the nominal exchange rate regime in place. Nevertheless, exchange rate stability is an important factor that may influence the investment allocation decisions of household, firms and governments for the acquisition of capital goods and the development of new technologies that may increase productivity. Excessive floating or a persistent trend towards depreciations should worry policy makers, especially if their economy is characterized by a growth process dependency to imported capital and foreign technologies[101].

Interesting avenues for future research emerge from our findings. Future research should re-examine the role of exchange rates in traditional models of economic growth while accounting for the growth process dependency to imported capital and foreign technologies in developing countries. It would be interesting to examine a possible classification for real exchange rate regimes. In addition, it would be worthwhile to re-evaluate the development benefits of export-led growth in Latin America while taking into account the dependency of these economies to imported capital.

[101] The results presented here should not be directly applicable without modifications to emerging market economies, nor to other developing countries which may have a different economic structures than Latin America; and may not be characterized by a dependency to foreign capital and technology.

Chapter 3

Capital, economic growth and relative income differences in Latin America

3.1 Introduction

The growth performance of the Latin America economies have resulted in slight improvements in living standards and modest income growth relative to those of the advance economies over the last fifty years. On average, the vast majority of these economies are below a quarter of the United State per capita income level, despite experiencing episodes of growth accelerations beyond those of the industrial leader. Historically, economic growth seems not to have resulted in substantial improvements in relative income levels.

Development theories for the region have predicted this disappointing evolution of income levels. The Prebisch-Singer theory suggests Latin America appears to suffer from technological disparities derived from a dependency to imported capital and foreign technologies which leads to differences in per capita in income growth and uneven development (Prebisch, 1950, Singer, 1950, Prebisch, 1959). Since the process of technology diffusion has been historically uneven, these economies specialize in the production of primary agricultural products instead of producing consumer durables, manufactured goods and machinery as in the advanced economies (Baer, 1962). Provided this is the case, the long run growth performance of these economies is expected to be inferior to that of the industrialized countries, therefore characterized by lower relative income levels, lower living standards, and a poor economic development[102].

To address the relative economic backwardness of their economies, at the start of the 1950's several Latin American governments implemented various programs of import substitution industrialization (ISI) to drive inward development. Curtailing imports may provide domestic producers with the necessary incentives to domestically produce the manufactured goods and consumer durables that were being imported from abroad. In that order, producers will seek to research and innovate in new technologies in order to increase domestic productivity, rather than relying on foreign capital and technology. However, while the ISI policies restricted the importation of final goods and unnecessary intermediate inputs, they promoted domestic production via facilitating the importation of key capital equipment and production inputs under preferential conditions (Baer, 1984)[103].

The economic imbalances created by the imports substitution policies lead to numerous crisis and their general abandonment at the beginning of the 1980's. The governments of the region returned to an economic policy of outward development by export-led growth that was still fundamentally based on the production of primary products and limited manufactured goods (Franko, 2007). However, the export-led approach remained crucially dependable on imported inputs[104]. Rather than focusing on the structural reforms to address the dependency to imports, macroeconomic policy aimed at

[102] Latin America also seems to suffer from a poverty cycle of the type described by Nurkse (1952), where low income leads to a lower savings, lower investments, meagre capital accumulation and poor productivity growth.

[103] In an early study about the region's productivity, Bruton (1967) shows that productivity growth during ISI was primarily achieved by physical capital accumulation and using excess capacity rather than by domestic innovations in new technologies.

[104] In this line of research, Hummels et al. (2001) documents the increasing vertical specialization in international trade for a selected sample of OECD and developing countries from 1970 to 1990. By vertical specialization they refer to the increasing use of imported inputs in the production of the export goods.

stabilizing economies plagued by current account deficits, high levels of external debt, high inflation and dual currency markets mainly derived from the sensitivity of output growth to imports. The complexity of the region growth process posed difficulties to the design of theoretical and empirical growth models to explain the inner dynamics of the growth process in these economies[105].

The existing literature on capital accumulation and economic growth has been divided in terms of what are the main sources of growth across countries, and what are the growth effects of capital accumulation. Neoclassical and endogenous growth theory holds the view that economies characterized by high levels of capital stocks should experience high income levels, however higher growth rates are either primarily achieved by exogenous technological change—as proposed by Solow (1956) and Swan (1956)—or by endogenous technological change and economic policy as proposed by Romer (1986) and Rebelo (1991). However, there is strong support in the literature for the notion that the growth process in developing countries, and in particular that of Latin America, is likely to be endogenous[106].

Embodied or disembodied technological change in capital has also been a controversy in the literature, although the evidence tends to favour the embodiment hypothesis (Denison, 1964, Hercowitz, 1998). Capital accumulation, and in particular imported physical capital, is suggested to be a key driver of productivity and growth in developing countries; being capital imports an important channel of embodied technology diffusion. In this line of research, De long and Summers (1991) finds strong support for technology embodied in machinery and equipment investment, and concludes that machinery investments drives faster productivity and economic growth in a sample of 61 countries from 1960 to 1985. In an extension of their previous work, De Long and Summers (1993) also finds that equipment investment—both domestic and imported equipment—drives faster growth in 88 developing and advanced economies over the period from 1960 to 1985.

The evidence seems to suggest that international trade of capital, and in particular that of machinery equipment, drives economic growth. This view

---

[105] For a discussion on these issues see Arida (1986).
[106] See, for example, the works of Romer (1994) and Franko (2007).

generally implies that international trade of capital is a significant growth determinant. As Rodriguez and Rodrik (2001) argues, there are important debates on these issues, however we should not expect international trade of capital to be negatively associated with growth. In that order, Lee (1993) presents theoretical and empirical evidence indicating that trade distortions and restrictions to the availability of imported capital are detrimental for long term economic growth, particularly when the domestic production crucially requires domestic and imported inputs[107].

An important examination on the role of capital imports on economic growth in developing countries is that undertaken by Lee (1995) where by extending Rebelo (1991) two sector endogenous growth model to an open economy, it is shown that by using relatively more capital imports than domestic capital, the less developed countries experience a faster rate of per capita income growth. Lee (1995) then proceeds to examine 89 countries over the period from 1960 to 1985 finding that per capita income grow faster in countries that have increased their ratio of capital imports in investment.

While De Long and Summers (1991, 1993) and Lee (1993, 1995) holds the view that imported capital in the form of machinery equipment investments drives faster growth, they also suggests that domestic capital is beneficial for growth. However, their studies do not clearly distinguish specifically between domestic and imported capital, nor between equipment and non-equipment investments. Improving on these limitations, Mazumdar (2001) specifically disaggregated between imported and domestic equipment in 30 developing countries from 1965 to 1990, finding that imported machinery equipment drives faster growth, however investments in domestic equipment reduces the growth rate of per capita income. In addition, Mazumdar (2001) suggests that domestic and imported non-equipment capital has an insignificant role in the growth process of the less developed countries.

For the case of Latin America, the evidence on the role of imported and domestic physical capital on economic growth has been more controversial. The Prebisch-Singer theory and the structuralist approach to economic development view the creation of domestic capital and domestic production

[107] Lee (1993) primarily use an open economy neoclassical growth model where restrictions and distortions to international trade decreases the growth rate of per capita income.

facilities as one of the main determinants of growth and development in the region (Singer, 1950, Prebisch, 1959, Furtado, 1965). On the contrary, others ascribe total factor productivity growth to be the primary source of long-run growth (De Gregorio, 1992a, Daude and Fernández-Arias, 2010). In what follows we briefly summarize the primary evidence for the region.

Studying the growth process in 12 Latin American economies from 1950 to 1985, De Gregorio (1992a) finds that total factor productivity growth is the main determinant of economic growth in the rapid growing economies of the region. In addition, investments in human and physical capital are found to be key growth drivers along with macroeconomic stability. On the issues of productivity growth—particularly that of productivity in manufacturing industries—Paus et al. (2003) finds that capital imports and trade liberalization were beneficial for productivity in 7 Latin American countries over the period from 1970 to 1998. Moreover, Paus (2004) show that the acquisition of capital imports have significant effects on productivity.

In a growth accounting exercise for 6 Latin American economies from 1960 to 2002, Gutierrez (2005) shows that machinery and equipment investments are the major growth drivers, however total factor productivity growth made the difference between a faster growth performance[108]. Solimano and Soto (2005) studied medium and long-run growth in Latin America during the last century, finding that there have been a general slowdown in economic growth rates since the 1980's. However, they attribute an important proportion of that slowdown in growth to declines in the rate of capital formation. In addition, their results show that productivity growth has actually declined in 7 out of the 12 Latin American economies under study.

Examining the growth process of the 6 largest Latin American economies over the last century, Astorga (2010) finds that human and physical capital accumulation are the key drivers of output per worker. Trade openness was found to be positively associated with higher growth via the investment channel, and macroeconomic instability was found to be detrimental for growth performance. On the contrary, in a study on productivity and factor accumulation in Latin America, Daude and Fernández-Arias (2010) finds that poor relative income growth in the region proceeds from slow productivity

[108] Gutierrez (2005) also documents that after the 1980's human capital has been an insignificant driver of economic growth in Latin America.

growth, being productivity at half of its expected potential, while capital accumulation does not primarily account for the region lack of convergence towards the advanced economies income and productivity levels.

The diversity and complexity of growth experiences across different income levels, and the lack of data availability for the vast majority of the Latin American economies, have make a comprehensive study of the growth process in the region a difficult endeavour[109]. Several of the studies for Latin America have rely on a limited sample of countries due to data availability, whose results are expected to extend in a similar fashion to the other small developing countries in the region.

This chapter contributes to existing studies on economic growth and development in Latin America by examining the growth effects of domestic and imported capital on economic growth and relative income difference in thirty-two Latin American countries over a period of fifty-years from 1960 to 2010. Our selection of countries can be considered one of the largest ever used in the existing literature to study growth performance in the region. This chapter compiles a new macroeconomic panel dataset for all the countries during the time span of the data, with more than ten growth determinants which includes information on domestic and imported physical capital, human capital, economic policy indicators and other economic aggregates, thus facilitating the study of economic growth for the vast majority of the developing economies of Latin America.

Our aim is to uncover new evidence in order to provide answers to the key old questions related to the growth and development performance of the region: Are capital imports with embodied technologies the most significant drivers of economic growth and relative income levels? Have domestic physical and human capital played a major role in explaining the region's growth performance? Does capital accumulation explain the variety of growth experiences that we observe across different income levels? Is there a dependency of the growth process to capital imports of the type suggested by the Prebisch-Singer theory?

To define imported and domestic capital in Latin America, we extend and adapt the methodology proposed by Lee (1995). In that order, we disaggregate between changes in capital imports and domestic physical capital in a

[109] Gutierrez (2005) recognized these difficulties.

consistent procedure that can be applied to the developing economies of Latin America. Our domestic capital measure is defined by equipment and non-equipment capital, being capital imports primarily composed by machinery equipment.

Our methodology differs from that of De Long and Summers (1991, 1993), Lee (1995) and Mazumdar (2001) in three important directions. First, we consider machinery equipment imports reported by the domestic economy from the rest of the world; rather the ones reported as exclusively as imported from the OECD economies. In that order, our measure for capital imports accounts for international trade of capital between the developing countries of the region, and between these countries and the advanced economies. Second, our measure for domestic capital considers equipment and non-equipment capital that is domestically produced, rather than focusing only on domestically produced equipment. Third, our study essentially focus in the Latin American economies, therefore we seek to explain endogenous growth in these countries via the acquisition of domestic and imported capital given the Prebisch-Singer theory for economic development.

We propose two empirical growth models to examine the role of capital imports and domestic capital on economic growth and relative income differences. These empirical growth models builds on Lee (1995) theoretical contributions which show that trade distortions and restrictions to the availability of capital can be detrimental for long run economic growth. Our estimation procedure is based on a variety of different econometric methods and different specifications. In particular, we estimate our growth models using Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) two-step system generalized method of moments estimator following Roodman (2009a) programming with Windmeijer (2005) robust standard errors, small sample adjustments and collapsed instruments[110].

The main empirical findings of this chapter are as follows. First, countries in Latin America are able to grow faster by acquiring capital imports in the form of machinery equipment. Our findings indicate that not only machinery investments drive faster economic growth, but also that once endogenous

---

[110] This estimation procedure accounts for the endogeneity of the regressors, and our estimation results display stability and consistency across different alternative specifications.

interactions have been accounted for, the growth effects of domestic capital are insignificantly lower than those provided by machinery imports. There is a positive correlation between higher productivity growth rates and the acquisition of machinery imports in Latin America.

Second, countries that invest relatively more on domestic capital reduce faster their relative income differences. In other words, relative income to the Unites States grows faster in countries that invest relatively more on domestic equipment and non-equipment capital. Therefore, there is a significant role for domestic capital in reducing cross-country relative income differences in Latin America. While capital imports drives faster economic growth, domestic capital is a key determinant of higher relative income levels, therefore both sources of capital are needed to drive economic development towards advanced economies living standards.

Third, human capital appears to have insignificant effects in the Latin American growth process. Fourth our results indicate that countries which experienced a slowdown in growth rates where relatively richer in 1970, adopted less machinery imports, and did not invest enough in domestic capital. Fifth, the diversity of growth experiences across different income levels in Latin America suggests that economic policy, endowments, trade patterns and the level of institutional development have played a determinant role in the growth process.

The rest of the chapter is organized as follow: Section 3.2 provides a discussion on development theories for Latin America and the role of capital accumulation in the growth process. Section 3.3 presents the growth models specifications, estimation procedures, and data methodologies. Section 3.4 discusses the main empirical findings. Section 3.5 shows the robustness checks. Section 3.6 presents the conclusions and policy recommendations.

3.2 Latin America development theories and the role of physical capital accumulation

Growth performance in Latin America have been diverse across different income levels as macroeconomic policy has aimed at the stabilization of either the exchange rate or the price level. Common wisdom has traditionally implied that economic growth will improve living standards in these economies, thus resulting in long run convergence towards advance economies living standards.

Since the colonization period, countries in the region have relied on the importation of capital to augment production, covering a proportion of the acquisition costs either by debt or by increasing the exports of primary products (Franko, 2007). Such a dependency to imported capital is at the heart of a technological disparity at which these economies, due to a variety of structural factors, do not have the proper incentives to innovate but to depend on capital and technology created abroad. This is the essence of Singer (1950) and Prebisch (1959) technological disparities hypothesis.

A lower per capita income growth in the periphery results from technological disparities not only among the different sectors of production within the domestic economy, but also between the developing and the advanced economies. Since capital is primarily used in the production of the export good in the periphery, with a relatively lower share of capital being used in the other sectors of production, the rest of the economy is neglected to backwardness due to their lower technological capabilities. The advanced economies by specializing in the production of manufactured goods are capital intensive, and have a higher level of technology than economies in the periphery which are specialized in the production and exportation of primary products that requires less technological capabilities. In that order, the observed differences in relative income levels. This is a process of uneven-development (Singer, 1950, Prebisch, 1959, Baer, 1962, Frankenhoff, 1962).

This process of uneven-development seems to be particularly reinforced by a pattern of trade where the Latin American economies specialize in the production of primary products, and the importation of manufactured goods and capital. Given this type of specialization—labour intensive developing countries versus capital intensive advance economies—emerge a pattern of declining terms of trade. Given the Engle Law, the export prices and the demand for primary products exports are relatively stable in the advanced economies. On the contrary, in the periphery, there is an inelastic demand for imports that leads to higher prices of imported manufactured goods and capital. In that order, there are stable export prices versus higher import prices, therefore the observed declining terms of trade. This process succinctly describe the Prebisch-Singer theory of declining terms of trade.

The less developed countries of Latin America seem particularly trapped in a “vicious cycle of poverty”, where low income results in lower savings, lower investment, and hence lower capital accumulation and productivity (Nurkse, 1952). This cycle seems to be reinforced by the declining terms of trade, which implies increases in the costs of acquiring imported capital with embodied technologies that could help alleviate the technological disparity.

At the middle of the twentieth century, the proposed solution to address these issues in Latin America was to undertake various programs of import substitution industrialization (ISI). The objective of the ISI programs was to use the tools of economic policy, for example, overvalued exchange rates, tariffs, and import quotas, in order to restrict the importation of the final goods and services that were viewed as unnecessary for the industrialization project of these economies; while, at the same time, these programs gave subsidies and facilities to the importation of key capital goods and intermediate inputs of production for the key infant industries seen as important for industrialization (Baer, 1972).

The ISI strategies established few incentives for domestic innovation and productivity growth. ISI policies allowed the importation of key inputs of production at artificially lower relative prices under special conditions. In that order, domestic production became increasingly reliant on the use of imported inputs. While it was expected that domestic producers will innovate in new technologies thereby increasing their productivity and reducing the content of imported inputs in the production process, this final stage of the industrialization process did not occur to a large extent in these economies since domestic producers had access to low-cost capital to increase production. In a study of five Latin America economies from 1940 to 1964, Bruton (1967) documents that output growth in the region was primarily achieve by replacing existing capital and using excess capacity rather than by innovation and research in new technologies.

The several economic imbalances created by import substitution policies lead to severe macroeconomic crisis in these economies[111]. Given the low income capacity of the population there was a weak internal demand for the

---

[111] Among these economic imbalances are the neglect of the export sector, distortions in the relative prices of capital, and a low labour absorption capacity in the production process (Baer, 1972, 1984).

new domestically produced manufactured goods whose prices were relatively higher than similar ones produced abroad. In addition, the newly created industries were highly inefficient and with higher production costs than their counterparts in the advanced economies (Baer, 1984). In that order, the domestic imbalances created by the import substitution policies led to a slowdown in economic growth, inflation, dual currency markets and several crisis as macroeconomic policy aimed primarily at the stabilization of the economy (Furtado, 1965, Arida, 1986)[112]. The general abandonment of ISI policies began to occur in the late 1970's, while during the 1980's there was a consensus in the region to return to a more oriented outward development approach by export-led growth.

The return to export-led growth was accompanied by a focus in competitiveness and the use of undervalued exchange rates to promote exports. However, these policies also failed to address the main structural features of these economies. Undervalued exchange rates increased the acquisition costs of capital imports thereby decreasing capital accumulation with the technologies embodied with it. Moreover, exports were still based on primary products which did not required higher technological capabilities, and therefore the countries practically return to the scenario described by the Prebisch-Singer theory[113].

During the 1990's the economies in the region advocated to financial and trade liberalization with an excessive focus on competitiveness. As Krugman (1994) suggests, macroeconomic policies that aim to enhance competitiveness are likely to result in poor growth performance. Despite the attempts to revive a sustainable economic growth through outward development via export-led growth, economic growth in the region remained fragile (Astorga, 2010).

---

[112] In our view, the main problems of ISI policies were that they restricted the importation of key capital goods and intermediate inputs of production for the sectors seen as unimportant for industrialization project, while artificially lowering the prices of imported capital and intermediate inputs of production for the key infant industries. In that order, the sectoral differences in the relative prices of capital perhaps exacerbated the technological disparities between the different sectors of production thereby failing to create the proper incentives for domestic innovation and productivity growth.

[113] See Franko (2007) for additional discussions on these issues.

Today the region appears to suffer from the same structural features described by the early development economists of Latin America: a high dependency to imported capital, poor domestic innovation in new technologies, and modest productivity and relative income growth which crucially depends on capital imports. Moreover, these structural characteristics of Latin America appear nowadays to extend to other world developing regions. Hummels et al. (2001) documented the increasing use of imported inputs in the production of export goods in a sample of 14 countries from 1970 to 1990. In addition, De Long and Summers (1991, 1993) show that the acquisition of machinery imports are the key drivers of productivity and economic growth in developing economies.

Despite the historical evidence that capital accumulation is a significant driver of productivity and output growth, there is disagreement in the existing literature with respect to the primary source of growth across countries. In a different line of research to the one presented previously, Easterly and Levine (2001) suggests that exogenous total factor productivity growth rather than capital accumulation is the major determinant of long-run economic growth in developing countries. In that order, for Latin America, Daude and Fernández-Arias (2010) and Pagés (2010) also suggest that total factor productivity growth instead of capital accumulation is the main driver of economic growth and development.

To explain the evolution of international income levels across countries, Parente and Prescott (2005) have proposed a unified theory of economic development and a theory of relative efficiencies which shows that cross-country differences in economic policy may determine the countries choices of technology and the starting date of modern economic growth, thereby influencing long-run economic growth and development. This theory seems to account for the relative stagnation of Latin America income levels. In our view, economic policies in the region have restricted the use of imported capital across all sectors of production thereby limiting the use of foreign technologies that could be embodied in capital accumulation. At the same time, a reliance on imported capital has acted as a drag to innovation, productivity, and the development of domestic capital thereby inhibiting a sustainable economic growth and development.

These complex issues in the Latin America growth process signal that economic policies are an important determinant for long run growth. In addition, other factors such as institutions have been important in explaining the region growth performance. In that order, Acemoglu et al. (2001) suggests that the institutional heritage of the colonization in Latin America has been a key factor that may explain macroeconomic performance and long-run growth in the region. The level of institutional development has been a major indicator of the rule of law, macroeconomic stability and the security of property rights; factors that may contribute to innovation in new technologies. North (1989, 1991, 1994) have also suggested that institutions are vital for higher productivity and economic growth. Therefore, exogenous technological change in isolation, without capital accumulation, may not account for the evolution of income levels and long-run economic growth and development in Latin America.

There are few disagreements among economists that total factor productivity has played a major determinant role in the growth process of the Latin American economies. However, there are still vast controversies among economists whether technology is embodied or disembodied in capital accumulation[114]. Provided that capital imports contain embodied technologies, international trade of capital could be an important channel of technology diffusion among countries, and hence a major factor contributing to long-run growth.

In the next sections we turn to examine in detail the growth effects of domestic and imported capital in Latin America. Consistent with the growth and development theories for the region, we expect to find important evidence indicating that the acquisition of capital import is a significant driver of economic growth, and that capital accumulation, in addition to productivity, drives faster growth in the developing economies of Latin America.

3.3 Growth empirics

The empirical growth models presented in this section draws on the endogenous growth models proposed by Lee (1995) and Rebelo (1991). In a two-sector open economy with consumption and capital goods where the

[114] See Denison (1964) and Hercowitz (1998).

capital goods sector drive long run growth, Lee (1995) shows that a developing country may grow faster by importing relatively more capital, provided this imported capital is relatively cheaper and is an imperfect substitute for domestic capital. The foreign capital proceeds from an advance economy that is capital intensive, therefore the developing country grow relatively faster by importing the capital good and exporting the consumption goods, hence the corresponding convergence in living standards. The two-sector model characteristics are similar to those of Rebelo (1991), who considers an economy with a consumption good and a capital good sector where differences in resources lead to cross-country income differences and convergence in growth rates since these later ones are influenced by the preference and technology parameters.

An interesting feature of these types of endogenous growth models is that differences in resources and economic policies play an important role explaining the diversity of growth experiences across economies at different income levels. These are precisely the type of dynamics we viewed as important for Latin America. Failures to converge towards advanced economies living standards may be due to differences in development strategies, economic policies as well as endowments or total resources. In that order, growth is viewed as endogenous, that is, not entirely driven by exogenous technological change (Romer, 1986).

In this type of models capital is a key factor of production, and therefore capital accumulation plays a key role in driving faster growth across the transitional period towards the steady state[115]. In Lee (1995) open economy version of Rebelo (1991), imported capital is a key factor of production that also enhances the productivity of domestic capital. By importing relatively more capital from abroad, developing countries grows faster. In that order, higher taxes, import restrictions and quotas, dual currency markets and foreign exchange controls, by restricting the availability of imported capital may result in economic growth slowdowns. Therefore, trade distortions have a detrimental effect in long term economic growth (Lee, 1993).

There is significant and robust evidence indicating that a reduction in equipment investment, defined as electrical and non-electrical machinery,

---

[115] Note that in this type of models growth rates are equalized once the economy reaches the steady state.

inhibit economic growth and productivity in developing countries (De Long and Summers, 1991, 1993)[116]. In that order, it is not surprising that imported inputs and machinery equipment has an important role in the production process of goods and services in the less developed countries. In fact, Hummels et al. (2001) documents the increasing use of imported inputs in the production of export goods. In Chapter 2, we show that real exchange rate depreciations have a contractionary effect on productivity growth in Latin America, and suggests as a potential explanatory channel the increased acquisition costs of capital imports derived from currency depreciations[117].

It seems appropriate at this stage to specify a general definition for imported and domestic capital. Following Lee (1995), we define domestic capital as the value of total investment minus capital imports. We then proceed to define capital imports as equipment investments in electrical and non-electrical machinery reported by the domestic economy from the rest of the world. These imported machineries are expected to be key drivers of economic growth (De Long and Summers, 1991).

In recent years the literature has had a renewed interest in the cross-country evolution of relative income levels. There is an increasing interest on how relative income may influence individual's utility function and macroeconomic performance. For example, Clark et al. (2008) and Layard et al. (2009) provides the theoretical and empirical foundations to the introduction of relative income in the analysis of individuals utility function. In their empirical applications they use measures of relative income as an explanatory variable for a utility function in which the individual is concerned about the evolution of relative income levels. While in their study they use relative income as an explanatory variable, in this chapter relative income is the dependent variable, and serves as proxy for relative income differences among the Latin American countries and the industrial leader.

The evolution of developing countries income and productivity levels relative to that of the United States as industrial leader has been a key indicator of efficiency in production, economic growth and development

[116] Note that capital imports are normally considered as imported machinery equipment.

[117] Currency depreciations and foreign exchange market distortions may increase the prices of imported goods and services. For a discussion, see Lee (1993), Lizondo and Montiel (1989).

performance (Parente and Prescott, 2002, Durlauf et al., 2005, Daude and Fernández-Arias, 2010, Pagés, 2010). Moreover, traditionally, capital has played a key role in the explanation of per capita income differences across countries (Krueger, 1968). The understanding of the evolution of income levels in Latin America while accounting for capital accumulation and controlling for endowments effects, economic policies and macroeconomic conditions will allow policy makers to offer a meaningful economic advice to the region in order to achieve a sustainable economic growth and development.

3.3.1 Economic growth baseline specification

Our benchmark specification to estimate the growth effects of imported and domestic capital on economic growth in Latin America follows that of Lee (1995)[118]. However, our empirical approach extends that of Lee (1995) in three important directions. First, we specified a dynamic panel growth model to examine the growth effects of imported and domestic capital on economic growth. The Prebisch-Singer theory emphasize the important role of imported capital and foreign technologies in driving growth performance and explaining uneven-development in the region, therefore our interest in the growth effects of domestic and imported physical capital on economic growth in Latin America.

Second, we conduct a variety of different estimation procedures for growth econometrics in order to verify the validity of our results according to the dynamic panel estimation approaches outlined by Durlauf et al. (2005). Third, we employ an extended set of control regressors and alternative specifications. Fourth, our estimations essentially focus in the vast majority of the less developed and emerging market economies of Latin America. In that order, we estimate the following dynamic panel growth equation[119]:

---

[118] In a sample of 89 countries from 1960 to 1985, Lee (1995) estimated a cross-country growth regression using two-stage least squares to test the relationship between the ratio of capital imports in investment and economic growth. Note that Lee (1993, 1995) provides the theoretical endogenous growth models under which our empirical estimations are based. In these types of models, trade distortions and restrictions to the availability of capital imports may drag economic growth.

[119] See Barro (1991), Mankiw et al. (1992), Caselli et al. (1996), Bond et al. (2001) and Acemoglu (2009) for a discussion on the specifications of cross-country growth regressions.

$$\ln(y_{i,t}) - \ln(y_{i,t-1}) = \gamma \ln(y_{i,t-1}) + \beta k_{m,i,t} + \delta k_{d,i,t} + \iota h_{i,t} + \theta C'_{i,t} + \mu_t + l_i + \varepsilon_{i,t} \tag{3.1}$$

where $y_{i,t}$ denotes the logarithm of real GDP per capita; $y_{i,t-1}$ is the initial real GDP per capita at the beginning of the period, where a negative coefficient value ($\gamma < 0$) for the initial GDP per capita implies the model is consistent with the conditional convergence hypothesis in growth theory[120]. $k_{m,i,t}$ is either the growth rate of capital imports or alternative measures for imported physical capital like the ratio of capital imports in investment; $k_{d,i,t}$ is the growth rate of domestic capital; $h_{i,t}$ is the initial level of secondary school enrolment or human capital as investments in education; $C'_{i,t}$ is a column vector of control variables, with θ as the corresponding column vector of control parameters; μ_t are the time period specific effects; l_i are time-invariant country specific effects, and $\varepsilon_{i,t}$ is the country specific term. The panel dimensions are $l \in [1, \dots, 32]$ economies across $T \in [1, \dots, 10]$ five-year averages from 1960 to 2010.

Our primary selection of control variables includes the investment share, population growth, trade openness as measure for trade policies and trade distortions, inflation as a measure of lack of price stability and as an indicator of monetary policy, government consumption to control for fiscal policy, and a measure of macroeconomic crisis which accounts for periods of severe banking and currency crisis. These are normally standard choices for control regressors in growth econometrics[121]. In addition, we also account for the land size as a control for endowments, and tariffs rates and imports of goods and services in order to account for trade distortions and the level of total imports respectively. Furthermore, we also introduce a control for political instability and the level of institutional quality in the form of an institutional development variable. The time effects are introduced to capture common patterns of long run growth and exogenous shocks that may map to

[120] Under conditional convergence countries closer to their steady state experience a slowdown in economic growth (Barro and Sala-i-Martin, 1992).

[121] A more detailed specification on the variables definitions and sources is given in the data methodologies section and Appendix A.6. See also Durlauf et al. (2005) for a literature survey on the different studies that use similar control variables, and their application on empirical growth research.

Latin American economies. The country specific effects serve as controls for time invariant unobserved heterogeneity, that is, omitted variables that are time invariant in these countries[122].

3.3.2 Relative income differences specification

We now address the relationship between relative income growth, capital imports and domestic capital. Following Parente and Prescott (2005), we study the evolution of income levels in Latin America relative to the United States as industrial leader. In addition, while the empirical application of Lee (1995) considered the growth rate of GDP per capita income as a measure for income growth, we extended their approach by considering relative income growth with respect to the United States. Our motivation to examine relative income levels in Latin America draws on the observation that relative income in the region has remained at a quarter of the United States income despite modest episodes of economic growth in these economies (Parente and Prescott, 2005). In that order, we seek to examine the importance of domestic and imported capital on the performance of relative income levels in Latin America.

The level of institutional development has been a key factor in the security of property rights, the rule of law and the maintenance of political stability in the Latin American economies. In this regard, North (1989, 1991, 1994) suggests that institutions are key drivers of productivity innovations and economic growth in developing countries. Moreover, Acemoglu at al. (2001) also suggest that institutional development has played a significant role on macroeconomic performance and economic development in Latin America. Therefore, in our estimation we incorporate an institutional development measure as a key explanatory variable of the evolution of relative income levels in Latin America.

Following the dynamic panel cross-country growth equation (3.1), we examine the growth effects of domestic and imported capital on relative income growth in the Latin American economies by estimating the equation:

[122] See the data section of this chapter for additional details on the selection of control regressors and the motivation to include these in our estimations.

$$\ln\left(\frac{y_{i,t}}{y_{u,t}}\right) - \ln\left(\frac{y_{i,t-1}}{y_{u,t-1}}\right) = \phi\ln\left(\frac{y_{i,t-1}}{y_{u,t-1}}\right) + \beta k_{m,i,t} + \delta k_{d,i,t} + \iota h_{i,t} + \kappa I_{i,t} + \theta X'_{i,t}$$
$$+\mu_t + l_i + \epsilon_{i,t} \tag{3.2}$$

where $\left(\frac{y_{i,t}}{y_{u,t}}\right)$ denotes the PPP converted real GDP per capita relative to the United States (Heston et al., 2012); $\left(\frac{y_{i,t-1}}{y_{u,t-1}}\right)$ is the initial relative income at the beginning of the period, where a negative coefficient ($\phi < 0$) implies the conditional convergence hypothesis. $k_{m,i,t}$ is either the growth rate of capital imports or alternative measures for imported physical capital; $k_{d,i,t}$ is the corresponding growth rate of domestic capital or alternative measures for domestic physical capital; $h_{i,t}$ is the initial level of secondary school enrolment or human capital as investments in education; $X'_{i,t}$ is a column vector of control variables with θ as the corresponding column vector of control parameters; μ_t are the period specific effects; l_i are the time-invariant country specific effects, and $\varepsilon_{i,t}$ is the country specific term. The panel dimensions are $l \in [1, \dots, 32]$ economies across $T \in [1, \dots, 10]$ five-year averages from 1960 to 2010.

3.3.3 Data

In what follows we provide a description of our data structure, the economic relevance of the variables used in our estimations, and the motivation for their inclusion in our study. We also explain how our definitions may differ from those conventionally used in the literature[123].

Data is compiled for a panel of 32 Latin America economies. We filter out business cycle fluctuations by implementing five-year averages of the variables series, and the panel is unbalanced (Durlauf et al., 2005). Our data structure differs from others in the literature in two important aspects[124]: first, we use perhaps one of the most extensive samples of Latin American

---

[123] Appendix A.6 summarizes the variables definition and sources used in this chapter. The term covariate and variable is used interchangeably.

[124] Most studies for the region focuses on the six largest economies in Latin America, or a selected sample of emerging market and developing countries. See, for example, the works of De Gregorio (1992a), Gutierrez (2005), Astorga (2010), Daude and Fernández-Arias (2010).

economies. Second, we use a significant time horizon since our sample period covers fifty years from 1960 to 2010.

Our data extends that presented in Chapter 2 where we provided a similar comprehensive macroeconomic dataset for region over the period 1980-2009 to study exchange rates and productivity growth. The major data sources for our study are the Penn World Tables, the World Development Indicators (WDI) and International Financial Statistics (IFS).

As dependent variables that proxy economic growth and relative income differences we use the growth rate of real GDP per capita, and the PPP converted GDP per capita relative to the United States, and data is obtained from Heston et al. (2012). Income is measure relative to the United States since it is the traditional benchmark as industrial leader (Parente and Prescott, 2005).

Initial real GDP per capita and initial secondary school enrolment ratios are introduced as control measures for the initial levels of physical and human capital stock (Barro, 1991, Barro and Sala-i-Martin, 1992, Mankiw et al., 1992, Levine and Zervos, 1996). We also include a measure for initial income relative to the United States as proxy for the initial level of income[125].

Following De Gregorio (1992a) we control for government consumption and inflation. We introduce government consumption as share of GDP from World Bank (2013) as a control for fiscal policy. To account for monetary policy and inflationary spirals, we construct a measure that captures lack of price stability following the methodology proposed by Levy-Yeyati et al. (2010)[126].

There is substantial empirical evidence suggesting that the level of institutional development matters for macroeconomic performance in Latin America (Acemoglu et al., 2001). To address these concerns, we introduce a control for political instability in the form of institutional quality or institutional development.

Our institutional development measure proceeds from institutional constraints on the decision power of the executive (president) or veto points in

---

[125] Initial values refer to the variable value at the beginning of each five year period. The secondary school enrolment rates are obtained from World Bank (2013). We decided to use the educational data from the World Bank since it includes a wider sample of Latin America countries.

[126] We compute lack of price stability measure as the logarithm of one plus the inflation rate.

these economies. The hypothesis being tested is that constraints on policy changes may bring security to investors and should be correlated to higher economic growth. We use data obtained from Henisz (2012) Political Constraint Index (POLCON). Controls for severe macroeconomic crisis in the form of systemic banking crisis and currency collapses are also included. Data on banking crisis proceeds from Reinhart and Rogoff (2009) and Laeven and Valencia (2012). We use Reinhart and Rogoff (2009) methodology to calculate currency crisis for each economy as a nominal currency depreciation greater than 30%.

We also include a variety of control regressors that are traditionally seen as key determinants of economic growth according to De Gregorio (1992a), Lee (1995) and Astorga (2010). We include the investment share over GDP and population growth from the Penn World Tables, the land size (sq. km) as a proxy for endowments, and the tariff rates applied to all products in order to control for trade distortions. These latter ones are obtained from World Bank (2013).

A measure for real trade openness is also included to account for distortionary trade policies that may have a negative effect in the economy and hence may drag growth, especially if it is outward oriented. Since we are also accounting for the growth effects of capital imports, we need to control for the level of import capacity in these economies. In that order, following Lee (1995), we also control for the total level of goods and services imports, where data is obtained from the World Development Indicators.

One of the most important contributions presented in this chapter is the examination of the growth effects of domestic and imported physical capital in Latin America. We now turn to explaining the methodologies we have used to disaggregate between changes in capital imports and domestic capital.

For the construction of the domestic and imported physical capital series for Latin America we extend the methodologies proposed by De Long and Summers (1991, 1993) and Lee (1995). According to the methodology proposed by Lee (1995), capital imports are defined as machinery exports from the OECD countries to the domestic economy. These may include exports of transport equipment. In a similar fashion, De Long and Summers (1991, 1993) consider as equipment investment those that proceeds from investments in transport equipment, electrical machinery and other nonelectrical machineries.

To adapt Lee (1995) methodology to be implemented to the developing countries of Latin America, we proceed to define capital imports as the total value of imported machinery equipment from the rest of the world, therefore it follows that domestic physical capital results from the value of total investments minus capital imports. Our modified methodology differs from De Long and Summers (1991, 1993) and Lee (1995) in two important directions. First, we extend Lee (1995) definition of capital imports to include the importation of machinery (other than electric), and electrical machinery equipment reported by the domestic economy as imported from the rest of the world. Perhaps due to data availability at the time, Lee (1995) only considered as capital imports those machinery exports from the OECD to the domestic economy since these are more likely to be embodied with higher technologies that are key drivers for long term growth. We extend Lee's work by considering all imports from the rest of the world as having also some degree of embodied technologies that the country may use to improve its productivity potential and technological capabilities. Therefore in our definition of capital imports we include the imports of machinery equipment reported by the domestic economy to be obtained from the rest of the world.

Second, to avoid statistical inconsistencies, we not do include transport equipment in our capital imports measure. The concept of transport equipment includes automobiles, trains, aviation equipment and parts, whose value may well exceed those reported as total investment in GDP. In addition, it is likely that a considerable proportion of this transport equipment may be imported temporarily into the economy to be re-exported abroad after a period of time, or may simply be devoted for consumption or leisure transportation, hence not forming part of total investment and gross capital formation. To be more precise, in some countries in Latin America we find evidence that the value of total investment is relatively lower than the value of total imports in machinery and transport equipment, therefore the value of domestic physical capital could be negative[127].

[127] Recall that under Lee (1995) methodology domestic physical capital is calculated as total investment minus capital imports. Among the countries whose

It is important to bring an additional observation on why including transport equipment may bring additional statistical inconsistencies. Many of the countries in the region report statistics under different balance of payments (BOP) and system of national accounts manual (SNA)[128]. Hence many of them may classify some transport equipment as investment while others do not. This is one of the many reasons why in some of these economies the total values of imported machinery and transport equipment may well exceed those of total investment. Moreover, cross-country disaggregated national account data for the region is relatively scarce in order to perform an accounting decomposition on what types of capital are being considered as investment. Perhaps this is one of the main reasons why there is only a limited sample of Latin American countries in growth accounting exercises[129].

For these reasons, we proceed to abstract the capital imports analysis from that of transport equipment imports; although transport equipment is expected to be implicitly included in the total value of domestic physical capital. In that order, De Long and Summers (1993) also excluded from their analysis the investments on transport equipment since, according to their observations, these are likely to be influenced by demographic variables such as population growth and the rate of urbanization. Moreover, including transport equipment imports in the total measure of imported capital may only strengthen the role of capital imports in the growth process; therefore our estimations may be regarded as conservative.

Our country level data on imported machinery equipment proceeds from U.N. Comtrade database[130]. In that order, we compile data on capital imports for each of the thirty-two Latin America economies, and disaggregate among changes in domestic and imported physical capital[131]. Given our procedure we

---

total imports value in machinery and transport equipment exceeds those of total investment are, for example, Panama and Uruguay.

[128] See the countries report by the World Bank (2013) and the International Monetary Fund.

[129] See, for example, Gutierrez (2005).

[130] We use the standard international trade classification revision 1, sections 7.1 and 7.2 which correspond to nonelectrical and electrical machinery. We find support for using data from revision 1 since it covers a longer time horizon than other revisions, therefore increasing our sample observations.

[131] Note that data on capital imports and domestic capital is calculated in constant per capita U.S. dollars in 2005. See appendix A.6 for a detailed calculation of these variables.

have extended and adapted Lee (1995) methodology to be implemented to the wide diversity of developing and emerging market economies in Latin America.

3.3.4 Estimation procedure

The empirical growth models Eq. (3.1) and Eq. (3.2) are commonly estimated either by cross-sectional analysis using pooled ordinary least squares and the fixed-effects (within-group) estimators, or by using instrumental variables estimation procedures to address the endogeneity of the growth determinants. Among the instrumental variables estimators, the most commonly used alternatives in growth econometrics are the two-stage least-squares, the first difference generalized method of moments (GMM) estimator, and the system GMM estimator[132].

The difference between these estimators relies primarily on the assumptions about the data generating process and the explanatory variables. The pooled OLS and the fixed-effects estimators require the exogeneity assumption of the regressors, that is, explanatory covariates are uncorrelated with the residual term. This implies, for example, that explanatory variables like government consumption and inflation has a unique identifiable effect in the economic growth rate, and there is no possibility for reverse causation or simultaneity that may be capture by the error term.

The pooled OLS does not incorporate country specific intercepts, while the fixed-effects estimation do control for time invariant unobserved heterogeneity. In dynamic panels, that is, where the dependent variable is included lagged one period as a repressor, the pooled OLS estimator may be biased upwards and inconsistent. In a similar fashion, the within-group estimator is likely to be downward bias. Moreover, since conventionally five-year averages of the variables time series are normally used in dynamic panel, in the context of small time periods and a large cross-section of

[132] For a comprehensive review on estimation procedures in growth econometrics see, for example, Durlauf et al. (2005). Note that random effects model do not suit growth regressions of this type since in random effects model the country effects are assumed unrelated to the explanatory variables, and this requirement is violated in dynamic panel growth models.

countries, the pooled OLS and the fixed-effects estimators are prone to provide biased estimates about the coefficients (Durlauf et al., 2005).

Despite these shortcomings, these estimators are particularly useful when combined together to provide benchmark estimates of the coefficients when the variables are assumed to satisfy the exogeneity assumption. In our initial estimation strategy we impose the strong assumption of strict exogeneity among the regressors and the residual term. Therefore in the first stage of the estimation procedure we estimate Eq. (3.1) with the pooled OLS and the within-group estimator. Provided the equation adequately identify an important relationship among the regressors and the dependent variable our estimates should be stable across different specifications.

The reason for the pooled OLS and the fixed-effects estimator tendency to produce biased estimates in the context of dynamic panel growth regressions is due to the included lagged dependent variable as a regressors since it is expected to correlated with the fixed effects and the residual (Nickell, 1981). In addition, we should expect the explanatory variables to be endogenous in cross-country growth regressions. In other words, regressors may correlate with pasts and current realizations of the disturbance term. In that order, dynamic panel estimation procedures should correct for endogeneity and dynamic panel bias. An important line of attack to alleviate these issues is to implement an instrumental variables estimation approach.

In the second step of our estimation strategy, we estimate Eq. (3.1) using the two-stage least squares fixed-effects instrumental variable estimator (2SLS) following the programming proposed by Schaffer (2010). We test for the endogeneity among the lagged dependent variable and the capital measures. Namely, we estimate a variant of Eq. (3.1) where the lagged dependent variable, capital imports and domestic capital are assumed to be endogenous regressors. In order to verify the validity of our two-stage least-squares estimations we implement various instrumental variables specification tests. We use the Kleibergen-Paap *rk* LM underidentification test, where rejecting the null hypothesis implies that the estimated equation is identified (Kleibergen and Paap, 2006). The second test is a Kleibergen-Paap *rk* Wald F statistic for weak identification where this statistic is expected to be higher than Stock et al. (2002) critical values in order to reject the null of weak identification (Baum et al., 2003, Schaffer, 2010)[133].

To further examine instrument validity under the 2SLS approach, we implement the Hansen (1982) over-identification test under the null that the instruments used are uncorrelated with the error term, hence satisfying the orthogonality conditions and remaining valid instruments. Finally, we examine the endogeneity of the chosen regressors—the lagged dependent variable, capital imports and domestic capital—using a Durbin-Wu-Hausman endogeneity test under the null that the selected endogenous regressors can actually be treated as exogenous variables (Durbin, 1954, Wu, 1973, Hausman, 1978).

Important shortcoming of these types of instrumental variables estimators are as follow: first, not all the regressors can be specified as endogenous since we need to satisfy rank conditions, that is, the number of explanatory variables should exceed the number of instruments[134]. Second, it seems difficult to find strong external instruments outside those that may be available from the data generating process, and that can serve to expunge simultaneity from the specified endogenous regressors. Third, 2SLS seems to not perform well in the type of panel data structures that characterize growth regressions, that is, with a relatively small number of time periods and a large cross-section of countries.

Dynamic panel estimators for empirical growth models should produce consistent and efficient estimates in the context of small time periods and a large cross-section of countries while allowing endogenous regressors and controlling for individuals and time period specific effects. Such estimator in growth econometrics is proposed to be the system generalized method of moment estimator (Bond et al., 2001). The system GMM estimator estimate simultaneously two equations, one in first difference and another one in levels, from which appropriate instruments are selected from the data generating process according to the set of moment conditions derived from initial conditions and assumptions.

---

[133] Instruments may only be weakly correlated to the endogenous regressors, in which case there can be a bias that proceeds from weak identification. See Murray (2006) for a discussion on how to avoid and correct for potential weak or invalid instruments.

[134] See Heij et al. (2004) for an introduction to these issues.

The first difference GMM estimator is proposed by Holtz-Eakin et al. (1988), Arellano and Bond (1991). This estimator uses lagged levels of the variables as instruments for an equation in first differences, and can be implemented using a one-step or two-step estimator[135]. The first difference transformation removes the time invariant unobserved heterogeneity thus alleviating omitted variables bias. However, in the context of small time periods and persistent time series—such as those that characterizes growth regressions—the first difference estimator has been found to perform poorly in simulations. The difference estimator shows a downward finite sample bias as lagged levels of the variables appears to be weak instruments for the regressors (Alonso-Borrego and Arellano, 1999).

Arellano and Bover (1995) proposed the use of lagged first differences to estimate an equation in levels, in addition to the use of lagged levels as instruments for an equation estimated in first differences. This system estimator is suggested to improve the consistency and efficiency of the estimations. Blundell and Bond (1998) outlined the initial conditions, assumptions and requirements under which this system GMM estimator outperforms the first difference estimator, and the estimators based on non-linear moment conditions[136]. The system estimator relies on the non-serial correlation assumption in the disturbance term, the fixed effects non-correlation with the regressor first differences, and the stationary requirements. These conditions are suitable for growth econometrics in the context of dynamic panels with short time periods and a relatively large cross-section of countries (Bond et al., 2001).

Finally, in the third stage of our estimation procedure, we estimate Eq. (3.1) and Eq. (3.2) using the Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) two-step system GMM estimator following Roodman (2009a) programming with Windmeijer (2005) robust standard errors, small sample adjustments and collapsed instruments[137].

---

[135] We use the two-step estimator since it is asymptotically more efficient than the one-step counterpart (Roodman, 2009a).

[136] For a detailed discussion on GMM estimators based on non-linear moment conditions see, for example, Ahn and Schmidt (1995).

[137] Windmeijer (2005) introduced a finite sample correction for the two-step GMM estimator to correct for the standard errors downward bias in small samples. To avoid instrument proliferation, Roodman (2009a) propose a restricted use of lags, as well as the use of collapsed instrument, that is, the use of one instrument per

Standard errors are robust to heteroskedasticity and autocorrelation within cross-sectional units.

For the system GMM estimator we impose the assumptions of the non-serial correlation of the idiosyncratic shock and the fixed effects, as well as the initial condition that the dependent variable is predetermined. We also assume that the explanatory variables are endogenous, in the sense of being correlated with current and past realization of the error term. Let us denote $Z_{i,t}$ as the *1 x k* vector of endogenous regressors. Following Arellano and Bond (1991), we use the following moment conditions for $t = 3, \dots, 10$ *and* $a \geq 2$:

$$E[y_{i,t-a}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \tag{3.3}$$

$$E\left[(\frac{y_{i,t}}{y_{u,t}})(\epsilon_{i,t} - \epsilon_{i,t-1})\right] = 0 \tag{3.4}$$

$$E[Z_{i,t}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \tag{3.5}$$

The assumption that first differences of the covariates are uncorrelated with the time fixed effects results in the following additional moment conditions for the level equations instruments (Arellano and Bover, 1995, Blundell and Bond, 1998):

$$E[(y_{i,t-1} - y_{i,t-2})(l_i + \varepsilon_{i,t})] = 0 \tag{3.6}$$

$$E\left[\left\{\left(\frac{y_{i,t-1}}{y_{u,t-1}}\right) - \left(\frac{y_{i,t-2}}{y_{u,t-2}}\right)\right\}(l_i + \epsilon_{i,t})\right] = 0 \tag{3.7}$$

$$E[(Z_{i,t-1} - Z_{i,t-2})(l_i + \varepsilon_{i,t})] = 0 \tag{3.8}$$

Recall that in our system GMM estimation procedure we have assumed the regressors to be endogenous. This assumption implies that we use second and further lagged levels of the variables as instruments for the first difference equation, in addition to lagged first differences of the variables as instruments for the levels equations. When an explanatory variable is assumed predetermined—the case of the lagged dependent variable—the first lagged level of the variable and contemporaneous lagged first differences are

variable for each lag distance and zero for missing values, therefore allowing the instrument count to be linear in the time dimension. Small sample adjustments results in the t-test instead of the Z test for the variables, and when combined with collapsed instruments, it alleviates the bias that could be caused by many instruments (Roodman, 2009a).

also available as instruments[138]. These conditions are important since the choice of lag is dictated by our assumptions about how regressors may potentially correlate with the disturbance term. For example, any weakly exogenous variable will likely become endogenous after the first difference transformation; therefore the next period lag is expected to be uncorrelated with the error term.

To ensure the validity of our instruments choice, we use the Hansen (1982) overidentification test under the null that the selected instruments are valid, hence remaining orthogonal to the error component. This J test can also be viewed as an specification test that shows whether the model is correctly identified and specified (Roodman, 2009a). In addition, we use the difference-in-Hansen statistics to verify the validity of each of the instruments subsets used in the first differences and the levels equations.

Since the validity of the system GMM estimation relies on the assumption that the residuals are serially uncorrelated, we also verify the validity of our instruments implementing the Arellano and Bond (1991) serial correlation test under the null of no serial correlation[139]. We also rely on the standard guidelines to restrict the instrument count to the number of cross sectional groups, as well, as to test different instrument counts and control set specifications.

3.4 Main empirical findings

The key questions to be address in this section are essentially the following: First, does the accumulation of physical and human capital leads to higher economic growth and lower relative income differences in Latin America? Second, is this capital endogenously or exogenously related to the growth rate? Third, which of these types of capital—domestic, imported or human capital—is essentially more growth enhancing, and alleviates more cross-country relative income differences in the region? These questions have no

[138] See Roodman (2009a) for a review on the standard treatment and lag choices for predetermined and endogenous regressors in GMM estimations. Note that we could use additional lags as the moment conditions 3.3-3.8 suggests. However, to avoid over-fitting the regressors, we restrict our lag choice to the closest suitable lags.

[139] Recall that after the first difference transformation we should expect AR(1) serial correlation, therefore the Arellano and Bond (1991) serial correlation test looks for AR(2) serial correlation in the error component.

easy answers, however this chapter brings substantial and robust evidence indicating that by adopting imported capital the Latin American countries grow faster and reduce their relative income gap with the industrial leader[140]. Our results suggests that capital imports are a major channel of technology diffusion between countries, therefore driving faster growth.

Recall that through this analysis the term capital is considered as a broad disaggregate measure that includes domestically produced capital, capital imported from the rest of the world, and domestic human capital. The adoption of this concept follows from the definitions of physical capital accumulation provided by Solow (1956), Swan (1956), Rebelo (1991) and Lee (1995), as well as to the concept of human capital developed by Schultz (1960, 1961), Becker (1962), and Lucas (1988).

The effects of technological change as an engine of growth is not explicitly modelled in these estimation, and it is left as the proportion of economic growth that cannot be explained by capital accumulation, economic policy and endowments. Part of this technological change, perhaps the most important one, may be seen as incorporated implicitly through productivity embodied in capital imports, as well as domestic productivity innovations embodied in the creation of domestic capital goods and domestic human capital accumulation (Hercowitz, 1998)[141].

Table 3.1 presents the preliminary evidence on the growth effects of capital accumulation under different econometric methods. We first assume the explanatory variables are exogenously correlated to the real GDP per capital growth rate. In that order, the first set of results in Table 3.1, that is regressions (1) and (2), are obtained via the Pooled OLS estimation of Eq. (3.1). While controlling for time specific effects to capture long run shocks

[140] By the industrial leader we refer to the United States (Parente and Prescott, 2005).

[141] Note that it could be misleading to assume that the error term of the estimations represents technological change. The residuals of these regressions may represent both the proportion growth that can be attributed to unexplained exogenous technological change, as well as possible omitted variables. By including a diversity of control regressors across different specifications omitted variable bias may be alleviated. However, these are not enough reasons to suggest that the residual denotes exogenous technological change. For a discussion on the alternative interpretations of residuals terms in cross-country growth regression see Durlauf et al. (2005).

that may affect these economies, this estimation method does not account for time invariant unobserved heterogeneity.

Results from the Pooled OLS estimation in regression (1) shows that capital imports have an insignificant effect in the growth process, being the growth effects of domestic capital more significantly conducive to output growth than human capital and capital imports. This initial finding suggests domestic capital as a main engine of growth. Our results show that controlling for a variety of economic policy variables and determinants of capital accumulation such as the investment share, population growth, government consumption, lack of price stability, macroeconomic crisis, trade openness among others, are important for growth modelling. It should also be noted here that the coefficient of initial real GDP per capita is negative and significant thus showing support for the conditional convergence hypothesis in Latin America, that is, economies closer to their steady state will experience a slowdown in economic growth rates (Barro and Sala-i-Martin, 1992, Caselli et al., 1996).

When in lagged values of human capital are included in estimation (2), the results presented in Table 3.1 show that capital imports and domestic capital have a significant effect on output growth. However the lagged measure of human capital appears statistically insignificant in the estimation[142]. It seems to be the case that lagged values of human capital interacts to enhance the productivity and the growth effects of the physical capital. These findings support Astorga (2010) who also finds that physical and human capital are important drivers of economic growth in Latin America

[142] By estimation (2) it is meant regression 2 in Table 3.1. This terminology will be kept throughout the rest of the study. The choice of lags was determined from a System GMM perspective. Since human capital can be considered as a potential endogenous regressor, lagged levels of this variable dated $t-2$ are uncorrelated with the residual term.

Table 3.1

Evidence on the growth effects of capital accumulation

Dep. Var.: Real GDP Per Capita Growth Period: 1960-2010	*Pooled OLS estimator*		*Within-groups estimator*	*Two-stage least-squares fixed-effects estimator*	
	(1)	(2)	(3)	(4)	(5)
Initial real GDP per capita	-0.00814**	-0.00616	-0.0461**	-0.0284	-0.0150
	(0.00339)	(0.00415)	(0.0178)	(0.0324)	(0.0232)
Capital imports	0.000306	0.000821***	0.000677***	0.0000489	0.000772*
machinery imports growth	(0.000244)	(0.000209)	(0.000139)	(0.000406)	(0.000438)
Domestic capital	0.00156***	0.00145***	0.00114***	0.00209***	0.00104*
domestic capital growth	(0.000301)	(0.000316)	(0.000346)	(0.000765)	(0.000546)
Human capital	0.0119	0.0156	0.00561	0.0121	0.0285
initial secondary school enrollment	(0.00812)	(0.0167)	(0.0190)	(0.0183)	(0.0214)
Investment share	0.000390	0.000695	0.00185**	0.000419	0.00141
	(0.000315)	(0.000518)	(0.000671)	(0.00112)	(0.00124)
Population growth	-0.00314	0.000318	-0.00228	-0.0109	-0.00906
	(0.00257)	(0.00425)	(0.00445)	(0.00734)	(0.00749)
Government consumption	-0.0220***	-0.0207**	0.00468	0.00551	0.00174
	(0.00638)	(0.00928)	(0.00730)	(0.0106)	(0.0103)
Lack of price stability	-0.0138***	-0.0105*	-0.00825*	-0.0158**	-0.0121
	(0.00437)	(0.00595)	(0.00429)	(0.00626)	(0.00798)
Macroeconomic crisis	-0.00741**	-0.00529	-0.0149*	-0.00484	-0.000369
banking and currency	(0.00315)	(0.00834)	(0.00807)	(0.0118)	(0.0163)
Trade Openess		0.00598	-0.00550	-0.0108	-0.0166
		(0.00515)	(0.0117)	(0.0198)	(0.0232)
Initial secondary school enrolment		0.00855	0.0217*	0.00128	
lagged two periods (t-2)		(0.0107)	(0.0120)	(0.0217)	
Constant	0.104***	0.000808	0.303		
	(0.0337)	(0.0582)	(0.225)		
Time effects	Yes	Yes	Yes	No	No
Country specific effects	No	No	Yes	Yes	Yes
Adjusted R-squared	0.59	0.68	0.76	0.47	0.61
F-statistic	0.00	0.00	0.00	0.00	0.00
Instrumental variables specification tests					
Kleibergen-Paap *rk* LM statistic				0.23	0.31
Kleibergen-Paap *rk* Wald F statistic				1.42	4.75
Hansen *J* statistic				0.81	0.13
Endogeneity test				0.06	0.68
Observations	149	78	78	63	48
Number of countries	30	23	23	16	15

Notes: Two-stage least-squares fixed-effects instrumental variable estimation following Schaffer (2010) programing. Estimation (4) considers the initial real GDP per capita, capital imports and domestic capital as endogenous regressors being instrumented by their lagged levels up to the third lag (initial GDP uses the second lag), in addition to the land size, institutional development and total imports of goods and services. Regression (5) considers only capital imports and domestic capital as endogenous regressors, these being instrumented by their lagged levels up to the third lag, in addition to the second lag of the initial school enrolment, the land size, institutional development and total imports of goods and services. Standard errors are given in parenthesis. The specifications tests report the p-values.

***Significant at 1%, **Significant at 5%, *Significant at 10%.

An initial shortcoming of this methodology is that previous estimates by Pooled OLS do not take into account unobserved heterogeneity and endogenous interactions. A first line of attack to alleviate the potential bias caused by unobserved time invariant heterogeneity in the estimates is to introduce country specific effects. This type of estimation is carried out with the within-group (fixed-effects) estimator in regression (3). When country fixed effects are included, the results confirms the growth enhancing effects of capital imports, domestic capital and human capital on economic growth.

The initial estimates suggest that domestic capital is more productive than both human capital and capital imports. Intuitively, a 1% increase in domestic capital is expected to yield a 0.11% faster economic growth in Latin America. The investment share of output also appears to be a major determinant in the growth process.

Note that the adjusted R-squared of these models is more that 50% of the economic growth rate. It implies that with this modelling we should be able to explain at least half of the region growth process. One of the main hypotheses handled in this chapter is that capital imports are an important channel of technology diffusion between countries. Provided this is the case, and that developing countries have a technological disparity of the type described by the Prebisch-Singer theory, we should expect capital imports to be more productive than domestic and human capital, allowing technology to be diffused from advanced economies to developing countries[143].

A potential concern regarding the role of domestic capital in the growth process is that endogenous dynamics between the regressors and the residual terms may be influencing the results. To address these issues, regressions (4) and (5) in Table 3.1 presents the estimation results of Eq. (3.1) via the two-stage least-squares fixed effects estimator following the programming proposed by Schaffer (2010) for instrumental variables estimations. In that order, in regression (4) we allow for endogenous interactions between initial

[143] Note that productive means in this context that capital imports should enhance both productivity and economic growth. The assumption that higher productivity leads to higher economic growth is adopted throughout this chapter. Prebisch (1959) suggested a technological disparity between advanced countries (the centre) and developing countries (as the periphery), in which the periphery have a lower technological state and depends from technology created in the centre to improve their economic growth and development.

income, capital imports and domestic capital[144]. Our results indicate that after partially controlling for the potential endogeneity of these regressors, domestic capital still have a significant role in the growth process of the Latin American economies. These results may also be interpreted as suggesting that if technological change is embodied in domestic physical capital accumulation, then domestic innovations are an important engine of growth.

This estimation also detects significant endogeneity dynamics between initial real GDP per capita, capital imports and domestic capital with the error term. The endogeneity test indicates that at the 10% significance level we should reject the null that these regressors as a group should be treated as exogenous. The specification from regression (5) considers capital imports and domestic capital as the only endogenous regressors. After testing for this possibility, we can observe that capital imports and domestic capital have a significant role in the growth process.

Three important findings are derived from the results presented in Table 3.1. First, there are growth enhancing effects of capital imports and domestic capital robust to a variety of econometric assumptions. Second, the coefficient estimates are relatively well stable across different specifications. Third, domestic capital is an important driver of economic growth in Latin America. Fourth, the specification tests suggest the presence of endogeneity between some of the regressors and the residual term.

The specification tests from the two-stage least-squares regressions show that the instruments used in regressions (4) and (5) may not have accounted for all the endogenous interactions between the regressors and the error component. In addition, the instruments appear to be relatively weak and the specification seems under-identified[145]. To address these issues, a system generalized method of moments (System GMM) estimation approach is conducted and presented in the following subsection. The system GMM

[144] See the estimation table notes on how the endogenous regressors were instrumented.

[145] The Kleibergen and Paap (2006) *rk* Wald F statistic fail to reject the null of under-identification, and the Wald statistic of weak instruments is below Stock et al. (2002) critical values and the Stock et al. (2002) traditional threshold of 10. Moreover, when only subsets of covariates are considered as endogenous, the Hansen (1982) *J* statistic for instruments validity is very close to the 10% confidence rejection region. The struggle to find appropriate instruments to carry out 2SLS instrumental variables estimation motivates the use of system GMM estimations.

procedure allows the explanatory variables to follow an endogenous dynamic process, that is, they are correlated with current and past realizations of the error component.

3.4.1 The growth enhancing effects of capital accumulation in Latin America

In order to properly answer our key questions, we need an econometric approach that allows us to deal with endogeneity, omitted variables bias and potential measurement error. From this subsection onwards, the analysis is carried out using a system generalized method of moment's estimation (System GMM) approach. In particular, we implement the Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) estimator following Roodman (2009a) programming[146]. All the estimations include Windmeijer (2005) finite sample correction, small sample adjustments, Roodman (2009b) collapsed instruments, and time specific effects. Under these specifications we should dramatically alleviate omitted variables bias, measurement error and simultaneity in the growth models (Bond et al., 2001).

The baseline equation being estimated is Eq. (3.1). The sample estimation period includes fifty years from 1960-2010. As previously discussed, the system GMM approach allows for the possibility that all the regressors are endogenously correlated with the error component. Strong support is found in the literature to control for endogeneity, omitted variables bias and measurement error using these types of specifications (Caselli et al., 1996, Blundell and Bond, 2000, Durlauf et al., 2005).

Table 3.2 presents the key findings concerning the growth effects of domestic and imported capital on economic growth in Latin America. After controlling for endogeneity among all the regressors, there are robust and significant growth effects of machinery imports in economic growth[147]. In other words, by adopting relatively more capital imports, countries in Latin America are able to grow faster. The growth effects of capital imports are also

---

[146] See section 3.3 for additional details on the models assumptions, moment conditions and specification tests.

[147] Recall that Table 3.1 also shows that there are significant growth effects of capital imports if we adopt the assumption that the regressors are strictly exogenous.

found to be relatively higher than those of domestic and human capital once endogenous interactions have been accounted for. These results coincide with the hypothesis that capital imports are an important channel of technology diffusion between countries. By importing machinery with embodied technologies developing countries grow faster.

The estimates are relatively well stable across a variety of different control regressor specifications. In the first set of estimations in Table 3.2, we control for main determinants of economic policy, the total imports of goods and services, and trade openness. After controlling for the level of total imports and real trade openness we can observe a higher effect of capital imports on economic growth. Intuitively, according to the results presented in regression (3), a 10% increase in capital imports should drive growth by 1.3%. Note here that the expected increase in growth is less than proportional to the increase in capital imports. This should be the expected result if we are willing to assume that there is a less than proportional embodied technology in these imports. There is no reason to believe countries are willing to incur in the adoption of foreign capital if this can be highly substituted, and is of unchanging quality as human and domestic capital.

Taking these estimates to the limit, if one is also willing to assume that physical and human capitals are perfect substitutes and of unchanging quality, one can incur in attribute the growth enhancing effects of capital imports only to embodied technological change. These estimates should be viewed in a wider perspective. By enhancing growth it should be the case that capital imports should be embodied with higher technology and of superior quality than human and domestic capital, since otherwise countries may be tempted to adopt the latter's to grow faster.

Table 3.2

Domestic and imported capital effects on economic growth in Latin America

Dep. Var.: Real GDP Per Capita Growth	Period: 1960-2010				
	(1)	(2)	(3)	(4)	(5)
Initial real GDP per capita	-0.0124	-0.00734	-0.00611	-0.0149	-0.00976
	(0.0127)	(0.0127)	(0.0133)	(0.0142)	(0.00817)
Capital imports	0.000969**	0.00106*	0.00129***	0.000742*	0.000824**
machinery imports growth	(0.000408)	(0.000611)	(0.000441)	(0.000403)	(0.000337)
Domestic capital	0.000388	0.000451	0.000881	0.000693	0.00161
domestic capital growth	(0.000871)	(0.00145)	(0.00125)	(0.000557)	(0.00139)
Human capital	0.0546	0.0350	0.0265	0.0583	0.0467
initial secondary school enrollment	(0.0366)	(0.0613)	(0.0427)	(0.0410)	(0.0572)
Investment share	0.000673	0.00178	0.00131	0.000927	0.00150
	(0.00126)	(0.00298)	(0.00245)	(0.00159)	(0.00166)
Population growth	-0.000786	0.00610	0.00590	0.000858	0.00611
	(0.0114)	(0.0139)	(0.0118)	(0.00823)	(0.00835)
Government consumption	-0.00887	-0.0180	-0.0193	-0.00699	-0.0123
	(0.0193)	(0.0260)	(0.0245)	(0.0163)	(0.0215)
Lack of price stability	0.00181	-0.00816	-0.00536	0.000480	-0.00471
	(0.0107)	(0.0163)	(0.0121)	(0.0110)	(0.0193)
Macroeconomic crisis	-0.0241	-0.00914	-0.0112	-0.0223	-0.0118
banking and currency	(0.0153)	(0.0386)	(0.0360)	(0.0152)	(0.0193)
Imports of goods and services		0.00243	0.0101		
		(0.0310)	(0.0363)		
Trade openness			-0.00504	-0.00444	
			(0.0218)	(0.0138)	
Institutional development					0.0132
					(0.153)
Constant	-0.105	-0.0832	-0.0501	-0.0921	-0.117
	(0.115)	(0.260)	(0.191)	(0.125)	(0.264)
Specification Tests					
i) F-statistic	0.00	0.00	0.00	0.00	0.00
ii) Serial Correlation					
Arellano and Bond AR(2)	0.39	0.76	0.46	0.25	0.56
iii) Hansen J statistic for instruments validity	0.72	0.58	0.62	0.75	0.60
iv) Difference-in-Hansen Statistic					
Lagged growth instruments	0.83	0.34	0.38	1.00	0.51
System GMM instruments	0.83	0.58	0.62	0.83	0.60
Observations	149	148	148	149	137
Number of groups	30	29	29	30	30
Instrument count	29	28	30	31	28

Notes: System GMM estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections and period specific effects. Small sample adjustments with collapsed instruments have been performed in all the estimations. This table reports the t-test instead of the z-test and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: All variables are treated as endogenous, except the initial output per worker which is assumed predetermined. Endogenous regressors use second lags for the difference equation and first lags for the levels equation. Predetermined variables use first lags for the difference equation and contemporaneous first differences for the levels equation. Estimation (4) uses an additional lag for the endogenous regressors in both equations. Standard errors are given in parenthesis. The specifications tests report the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

After controlling for the level of institutional development as a proxy for market distortion, the rule of law and property rights, it seems to be the case that the growth effects of capital imports are also reinforced. A variety of specification tests show the results are robust, and instruments are valid and informative as we keep the instrument count as low as possible given the sample observations and number of countries as suggested by Roodman (2009b). The Arellano and Bond (1991) second order serial correlation statistics test fail to reject the null of no serial correlation among the error component, a key assumption in system GMM. The Hansen (1982) J test, and the difference-in-Hansen statistic, show the selected instruments are valid, while the stability of the coefficients across different model specifications indicates the estimates are relatively close to their true value.

The system GMM estimations fits quite well the data generating process. Figure 3.1 show the growth experience of a selected group of countries in the region, the *in-sample* estimates for the growth rate, along with the predicted growth series in response to a permanent shock in machinery imports[148]. Two observations seems particularly important given the model mechanics. First, countries grow faster with the importation of foreing physical capital. Second, there is a variety of growth experiences in the region with common patterns of business cycles across different income levels.

These results bring support to previous findings in the endogenous growth literature. For instance, Lee (1995) show in an endogenous growth framework similar to Rebelo (1991) that capital imports may result in higher long run growth rates, and possibly induce a faster convergence towards higher living standards. Under their theoretical and empirical model mechanics, trade restrictions may yield lower long run growth rates by restricting the availability of capital.

[148] Selection was based on income group, country region and data availability.

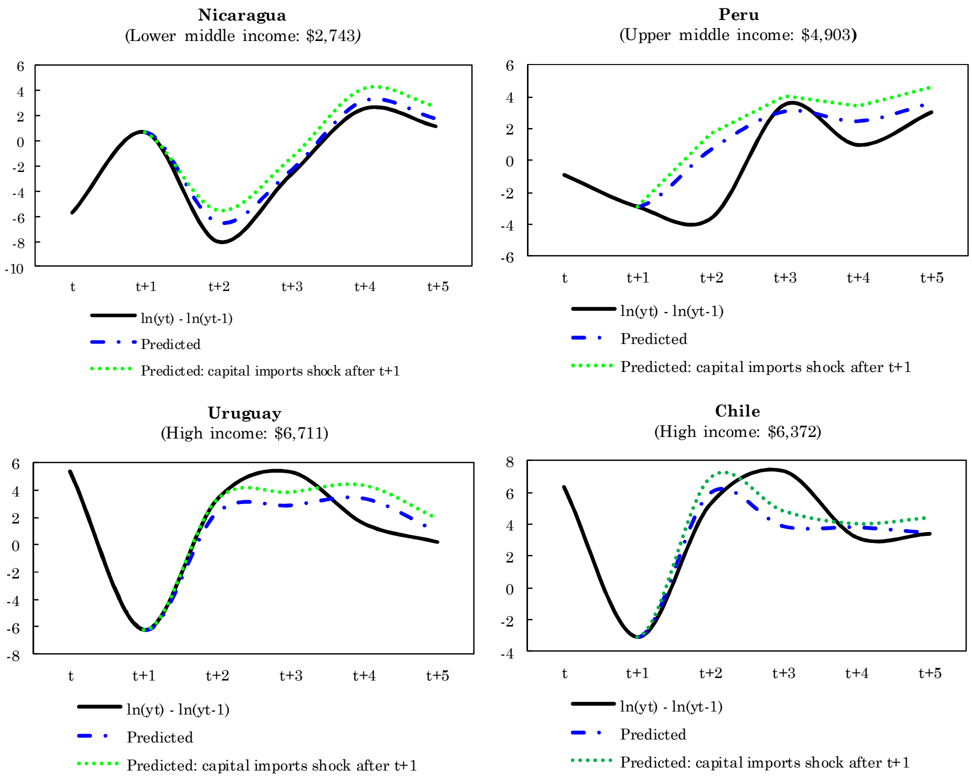

Fig 3.1. Economic growth response to capital imports shocks[149]. The left axis respresents the percentage growth rate of real GDP per capita[150]. Sample estimates are from regression (1) (Table 3.2), and the time span of the data is from 1975 to 2005 in "*t*" five-year averages.

We can interpret our findings as suggesting that the importation of physical capital, regardless of its place of origin, may have growth enhancing effects. The key point to be emphasize here is that for this foreign capital to have growth effects—perhaps due to embodied technology—it do not need to be solely imported from the advanced economies. Since our measure for capital imports considers machinery imports reported by the domestic economy from the rest of the world, our findings suggests that capital imports from lower income trading partners could also have important growth effects

---

[149] The shock is instrumented by a 10% permanent increase in capital imports after *t+1*.

[150] The level of per capita income is in constant U.S. Dollars in 2005, calculated by logarithmic differences. Data proceeds from Heston et al. (2012). The income level classification is based on the World Development Indicators.

in the domestic economy. If this would have not be the case, the estimation results will have shown an insignificant coefficient for capital imports. In that order, it appears to be the case that international trade of capital between the Latin American countries is as important as the expected one direction trade relationship from north to south.

These findings also seems plausible if we are willing to assume that each country, regardless of its level of development, is able to innovate in heterogeneous ways and in the same fashion as its trading counterparts, exporting abroad the fruits of their innovation. There is important evidence which suggests that historically capital have normally flown from advanced countries that are capital intensive to Latin America economies that can be considered labour intensive (Singer, 1950, Prebisch, 1959). However, a complete specialization of the type in which lower income countries specialize only in the production of labour intensive goods while higher income ones specialize only in the production of capital goods may not hold in the long run if we are willing to assume convergence in per capita income levels and technology of the type described by Barro and Sala-i-Martin (1992). By considering capital imports reported by the domestic economy from the rest of the world, our results indicate significant growth effects of capital imports through the trade of capital between developing countries, and between advanced economies and the less developed countries.

The international trade of capital between developing and emerging market economies is important. A significant proportion of machinery trade occurs in the South American region among *Mercosur* members and non-member countries, where Brazil is an important exporter of capital to other Latin American economies. Actually, the data used in this research shows that Brazil is the second major trading partner among many South American countries, in addition to the United States. In other world regions such as Asia, China, Japan and South Korea, have been traditional exporters of capital goods to other economies in that region. However, whether capital imports contain embodied technologies that may improve long-rung growth has been the subject of embodiment controversy in the literature (Denison, 1964, Hercowitz, 1998).

The fact that countries with a higher capital stock, perhaps obtained through the importation of physical capital, may have higher capital to labour ratios and possibly different growth rates that may result in higher living standards seems to be supported by neoclassical and endogenous models of economic growth[151]. Once countries have reached a higher development stage we should expect these economies to benefit less by importing foreign capital, especially if this capital is embodied with relatively similar levels of technology as human and domestic capital. However, in the place of restrictions to the creation of new capital in the domestic economy these economies may well benefited from acquiring capital from abroad.

The observation that there seems to be a variety of growth experiences in the region with potential common patterns of business cycles is not surprising. The Latin America economies have been traditionally characterized by common structural and nominal rigidities, as well as common social and institutional constraints such as the lack of property rights and poor investment in sectors not seen as important for the government (i.e. the agricultural sector). These common issues have shape their growth and development experience (Franko, 2007). Nevertheless, the growth model presented in this chapter seem to have fit quite well the data despite the variability in growth rates across different income levels.

On the role of capital imports in the production process, Hummels et al. (2001) finds significant evidence which suggests there have been increases in the share of imported inputs used in the production of export goods in advanced and developing countries. Our results can be reconciled with theirs as suggesting that machinery imports and imported input components have been significant drivers of economic growth in the developing economies of Latin America. In addition, it has been acknowledged in the literature the greater role of imported capital in the production of export goods and economic growth in the region (Singer, 1950).

Our results bring new evidence for Latin America, and establish new stylized facts for the region by extending and redefining previous findings in the literature. For instance, De Long and Summers (1991, 1993) show that machinery and equipment investments drives faster productivity and economic growth in advance and developing countries. In addition, our

---

[151] Acemoglu (2009) provides an outstanding treatment of these models assumptions and theoretical results, as well as their implications for modern growth research.

findings indicate that not only machinery investments drives faster economic growth, but also that once endogenous interaction have been accounted for, human and domestic capital drives faster growth but their growth effects are relatively lower to those provided by machinery imports.

As in Astorga (2010), our findings show the important role played by physical capital accumulation in the growth process of Latin America. Trade openness, population growth, government size and inflation appear to be negatively correlated with economic growth, while there are growth enhancing effects of higher investment and macroeconomic stability as those proposed by De Gregorio (1992a). In addition to De Gregorio (1992a) and Astorga (2010), however, our findings indicate an important but insignificant role of human capital in the growth process. Once simultaneity has been taken into consideration, our findings indicate that human capital is insignificantly related to faster growth. This result is in line with Gutierrez (2005) who also finds that secondary school enrolment rates as proxies for human capital are positive but insignificantly correlated with higher economic growth in Latin America since the 1980's.

Recently, total factor productivity has been suggested to be the main determinant of long term economic and productivity growth in Latin America (Solimano and Soto, 2005, Daude and Fernández-Arias, 2010, Pagés, 2010). Gutierrez (2005) supports the view that capital accumulation has been an important driver of growth (including capital imports with embodied technologies) however total factor productivity have been the key determinant between faster and slower growth rates experiences. Our findings are reconciled with theirs as suggesting capital imports as an important channel of technology diffusion between countries, driving faster technological change and economic growth.

Evidence from Figure 3.2 shows a positive correlation between higher productivity growth and machinery imports in Latin America during the last fifty years from 1960 to 2010. This relationship brings additional support to the widely held view that machinery imports may have embodied technologies that drive faster growth.

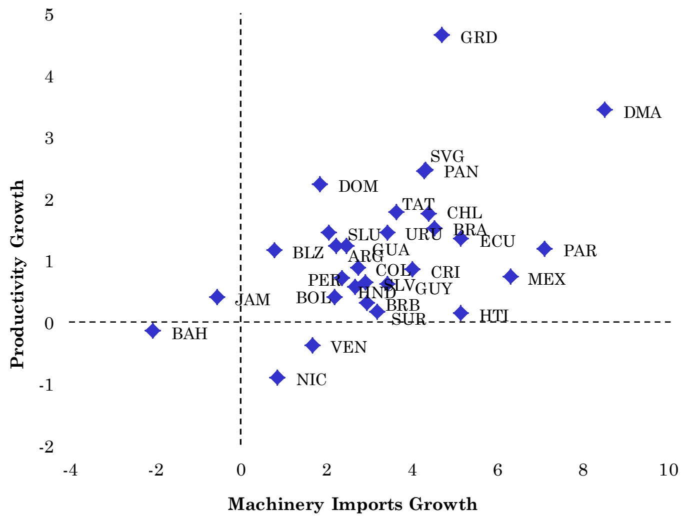

Fig 3.2. Productivity growth and machinery imports in Latin America, 1960-2010. Source: Author construction based on data from the Penn World Tables and the UN Comtrade[152].

In what follows, we now turn to answer the question of whether by adopting capital imports countries can reduce their relative income differences. For the cross-country income levels comparisons, the United States as industrial leader is proposed as the natural benchmark.

3.4.2 Capital accumulation and relative income differences

The evolution of per capita income levels in Latin America has been disappointing over the last fifty years. As of the end of 2010, a significant proportion of these countries, more precisely 16, has remain below a quarter of the United States income level. Many of these economies today are relatively worse off than in 1970 in terms of relative income to the industrial leader.

---

[152] Productivity growth is measure as the percentage growth rate of the real GDP per capita in constant U.S. Dollars in 2005 by logarithmic differences. Data proceeds from Heston et al. (2012). For the definition of machinery imports see the data methodologies in section 3.3.

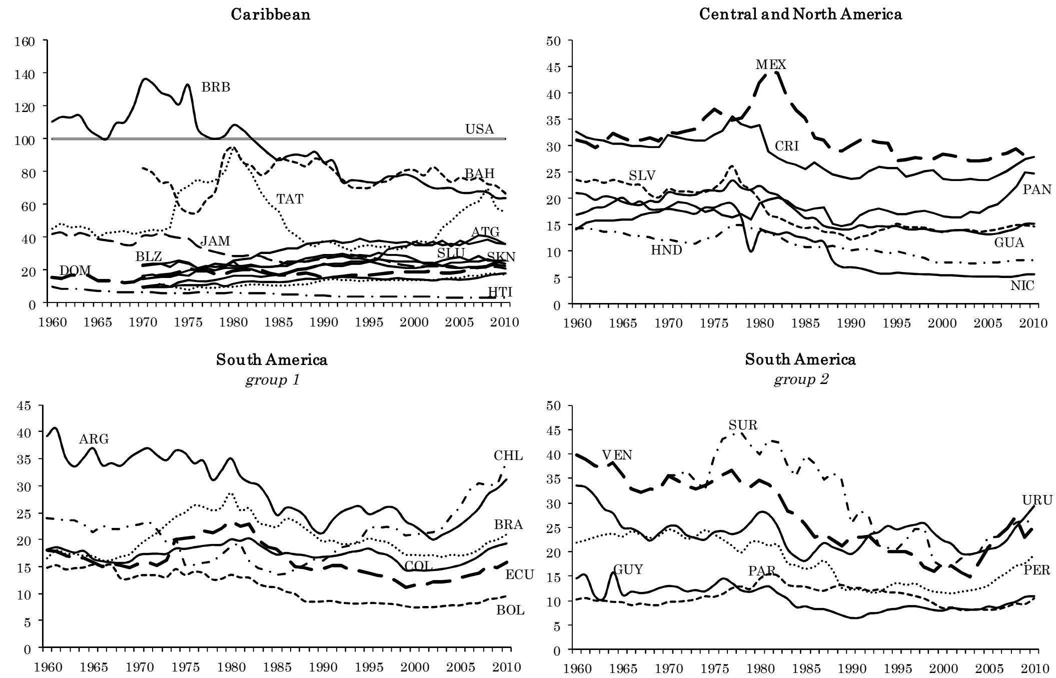

Fig 3.3. Relative income differences in Latin America, 1960-2010[153]. Income relative to the Unites States. Source: Author construction based on data from the Penn World Tables.

Figure 3.3 show the evolution of relative income levels in the region. A first striking observation is the downward cycle of income in the vast majority of these economies since the late 1970's, with a rapid period of catching up at the start of the twentieth first century. This downward phase coincides with the end of import substitution industrialization at the beginning of the 1980's, the debt crisis in the region during this decade, and the period of macroeconomic instability, high inflation and currency collapses during the late 1980's and the first half of the 1990's. The major top performers catching

[153] Data correspond to the PPP converted GDP per capita relative to the United States, G-K method (US=100). Data proceeds from Heston et al. (2012). See the country tables in Appendix A.1 for the lists of countries and acronyms.

up to US income levels are located in the Caribbean, namely Grenada, St. Kitts and Nevis, Antigua and Barbuda[154].

We now address the questions on what has been the role of capital accumulation in the evolution of relative income levels in Latin America. What have been the key determinants of relative income growth in the region, and more importantly what have been the role played specifically by capital imports, human and domestic capital in the growth process of these countries? Table 3.3 summarizes the key findings for these questions. Surprisingly, once controlling for the level of institutional development as a proxy for the rule of law, property rights and market distortions, our results indicate that domestic capital, as oppose to capital imports is the key driver to faster relative income growth.

While capital imports is a significant driver of relative income growth, our findings indicate that it is the formation of domestic capital that drives a faster relative income growth towards the advanced economies living standards. Moreover, despite that human capital is shown to have insignificant effects on relative income growth, investments in education are positively correlated with higher relative income.

In Table 3.3, regressions (1) and (2), indicate it is critical to control for the level of institutional development to understand the growth enhancing effects of capital accumulation in Latin America. This result is not surprising since countries with weak institutions are normally plague with political and economic instability that harms innovation and investment in physical and human capital hence dragging economic growth.

Controlling for endowments and trade policies by introducing controls for the land size and real trade openness do not change our qualitative results. Countries in Latin America have substantial shares of land and are normally very high open economies. Controlling for trade openness, however, suggest that capital imports drives relative income growth in highly open economies.

---

[154] Relative income performance was measure as the difference between the geometric average of relative incomes between 1970 and 2010, against initial income in 1970. The year 1970 was selected as an initial year for this statistical comparison due to data availability, and to maximize the sample size for all the thirty-two countries under study.

Table 3.3

Domestic and imported capital effects on relative income growth

Dep. Var.: Relative Income Growth	Period: 1960-2010			
	(1)	(2)	(3)	(4)
Initial relative income	-0.0181	-0.0185	-0.0121	-0.0180
	(0.0169)	(0.0190)	(0.0206)	(0.0189)
Capital imports	0.00127***	0.000454	0.000715**	0.000966*
machinery imports growth	(0.000387)	(0.00158)	(0.000317)	(0.000480)
Domestic capital	0.00243**	0.00211	0.00187*	0.00194
domestic capital growth	(0.00108)	(0.00137)	(0.00109)	(0.00118)
Human capital	0.0937	0.0803	0.0872	0.0800
initial secondary school enrollment	(0.0758)	(0.111)	(0.0538)	(0.0964)
Investment share	0.00103	0.00168	0.000724	0.00148
	(0.00196)	(0.00165)	(0.00162)	(0.00175)
Population growth	0.0141	0.0175	0.0118	0.0112
	(0.0116)	(0.0190)	(0.00911)	(0.0138)
Institutional development	0.139		0.0704	0.110
	(0.124)		(0.125)	(0.149)
Government consumption	-0.00531	-0.00312	-0.0158	-0.0159
	(0.0213)	(0.0329)	(0.0201)	(0.0170)
Lack of price stability	0.0235	0.00694	0.0120	0.0161
	(0.0221)	(0.0294)	(0.0148)	(0.0286)
Macroeconomic crisis	-0.0323	-0.0301	-0.0288	-0.0348
banking and currency	(0.0245)	(0.0444)	(0.0204)	(0.0276)
Land size			0.00253	
			(0.00518)	
Trade openness				-0.0125
				(0.0265)
Constant	-0.411	-0.328	-0.362*	-0.266
	(0.341)	(0.407)	(0.210)	(0.457)
<u>*Specification Tests*</u>				
i) F-statistic	0.00	0.00	0.00	0.00
ii) Serial Correlation				
Arellano and Bond AR(2)	0.21	0.15	0.16	0.32
iii) Hansen J statistic for instruments validity	0.95	0.80	0.67	0.93
iv) Difference-in-Hansen Statistic				
Lagged growth instruments	0.34	0.62	0.62	0.28
System GMM Instruments	0.95	0.80	0.67	0.93
Observations	137	148	137	137
Number of groups	30	30	30	30
Instrument count	28	26	30	30

Notes: System GMM estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample correction and period specific effects. Small sample adjustments with collapsed instruments have been performed in all the estimations. This table reports the t-test instead of the z-test and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: All variables are treated as endogenous, except the initial relative income which is assumed predetermined. Endogenous regressors use second lags for the first difference equation and first lags for the levels equation. Predetermined variables use first lags for the difference equation and contemporaneous first differences for the levels equation. Standard errors are given in parenthesis. The specifications tests report the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

The relative stability of our coefficient estimates suggests the system GMM approach has digested important endogenous relationships among the main growth determinants. In addition, our results indicate that higher investments and population growth insignificantly results in a higher relative income. This latter finding seems not to be abstracted from reality if we are willing to consider that an increase in population with a higher relative income may augment aggregate demand by increasing consumption, therefore driving economic growth. Actually, there is substantive evidence which suggest that one of the problems not considered by import substitution industrialization policies in Latin America was that countries did not have a sufficient strong internal demand to drive faster growth (Baer, 1972).

The fact that domestic capital drives a faster reduction in relative income differences is not striking. Solow (2005) suggests that after adopting similar technologies to the USA, some European countries have experienced a slowdown in growth. Our findings can be interpreted as suggesting that while it is plausible that the adoption of machinery imports drives faster economic growth in Latin America, it seems that the embodied technologies of these machineries maintain these economies in a relatively lower technological state, and dependency, from the industrial leader hence once the technological levels of these economies tend to equalize, so do tend to equalization the growth rates. This is precisely Prebisch (1959) technological disparity hypothesis. Hence the importance of innovation, imported and domestic capital formation to reduce relative income differences.

Our findings in this section support the view that only through domestic capital formation, innovation and human capital; countries in Latin America are able to reduce faster their relative income differences. Should countries disregard capital imports for long term growth? No, these results show there are significant growth enhancing spillovers from the adoption of machinery imports to increase the growth effects of human and domestic capital. Moreover, it is this growth enhancing effects of domestic capital to reduce relative income differences that may explain intra-regional trade of machinery imports between the Latin America economies.

The most plausible interpretation for our findings seems to be that given the technological disparities, countries in Latin America are able to grow faster by adopting machinery imports. Once technology levels are equalized, then human and domestic capital formation drive faster growth and reduce relative income differences. At a higher economic development level, countries may benefit from innovation and formation of domestic human and physical capital, being the later critical to sustain higher levels of living standards

The key role played by the economic policy variables and the level of institutional development in our findings brings new empirical support for Parente and Prescott (2005) theory of the evolution of international income levels. This theory builds on Hansen and Prescott (2002) who explain that countries transition from stagnation to modern economic growth once total factor productivity in the modern sector has achieved a critical value. It unifies it with Parente and Prescott (2002) theory of relative efficiencies which proposes differences in economic policies and institutions that restrict technology choices as key determinants of the observed cross-country income differences.

In our view, is important to reemphasize that technologies embodied in the adoption of machinery imports drive faster growth in lower income countries. Once the economies have reached a mature state of technology and development, then domestic and human capital formation seems to drive a faster economic and relative income growth. Across this growth process, total factor productivity, capital imports, domestic and human capital, as well as the institutions and economic policy variables, interact in an endogenous fashion to drive growth and reinforce the effects.

Countries in Latin America seem to benefit from stable macroeconomic policies and sound institutions. It is not surprising that our results are sensitive to the inclusion of the level of institutional development for the growth effects of capital accumulation to be significant. As North (1989, 1994) has pointed out, weak institutions tend to be associated to with slow growth and poor productivity levels.

We should sympathize with Parente and Prescott (2005) view that one of main reasons for the failing of Latin America to catch up with living standards in the United Sates are trade restrictions and the slow adoption of efficient production practices. In that order, we present evidence which indicates that initially the less developed countries in the region can grow faster by acquiring capital imports.

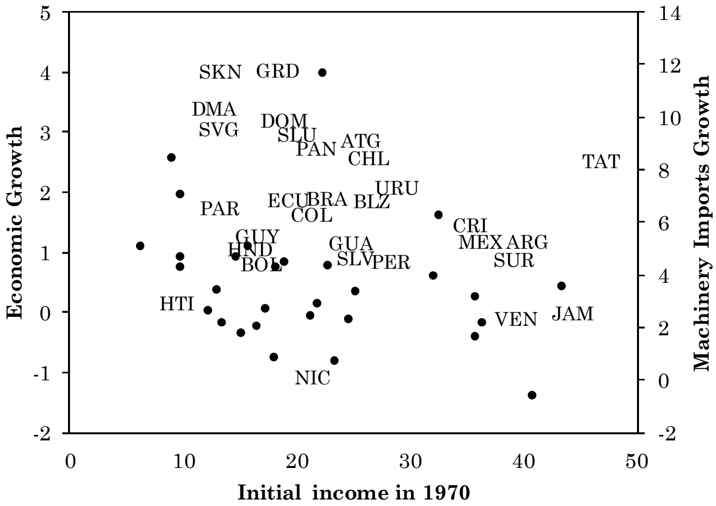

Fig 3.4. Convergence in Latin America[155]. Countries name represent the relationship between economic growth and intial income. Dot points represents the relationship between machinery imports and initial income. Source: Author construction based on data from the Penn World Tables and UN Commtrade,.

Although relative income in most of the Latin American economies has been at a quarter of the United States income, there is evidence of conditional convergence in growth rates with persistent relative income difference. Countries that have had a higher relative income in 1970 have experience a slowdown in growth rates relative to those countries that had a lower initial income. In other words, countries relatively poorer have grown faster. Figure 3.4 show a negative relationship between initial relative income and economic growth. This evidence brings renewed support for the conditional convergence hypothesis of the type suggested by Barro (1991), Barro and Sala-i-Martin (1992) and Caselli et al. (1996).

Figure 3.4 also seems to suggest that countries that have experienced a slowdown in growth, have adopted less machinery imports, and were relatively richer at the beginning. The diversity of growth experiences across

[155] For simplicity of the exposition Barbados and Bahamas are not shown in this graph. These countries had a ratio of relative income to the USA in the order of 135 and 82 percent, respectively, which values will be substantially to the right. The convergence relationship will not change if these values were included in the graph. Data uses the PPP Converted GDP per capita relative to the United States, G-K method (US=100). Data proceeds from Heston et al. (2012).

different income levels in Latin America also suggest that economic policy, endowments, trade patterns and institutional development have also played a determinant role in the growth process.

When all these interactions are analysed in an endogenous fashion by the system GMM empirical growth model proposed in this chapter, that is allowing for simultaneity among all the growth determinants and the residuals, substantial and robust evidence is found that these determinants have play an important role on economic and relative income growth, being the conditional convergence effect insignificantly negative. We interpret this finding as suggesting that poor growth performance is not systematically correlated with initial income.

Economic growth in Latin America seems to be nor totally independent of initial income, nor systematically correlated with it. Other factors have played a major role, among which we propose the technologies embodied in foreign physical capital in the form of investments in machinery imports. This analysis provide answers to the characteristics of relative income growth performance in the Latin America economies.

3.5 Robustness checks

This section now addresses a variety of robustness checks that have been performed to verify the validity of our results. We suggest the growth effects of physical and human capital are relatively invariant to the choice of econometric methodology (see Table 3.1). When the exogeneity assumption is adopted both capital imports and domestic capital are suggested to drive faster growth. However, across economies at different income levels the growth effects of domestic capital are relatively higher than those of capital imports. Once we allow for simultaneity among the regressors and the residual term, a clearer relationship appears: capital imports drive faster growth across countries at all income levels, while domestic human and physical capital drive a faster relative income growth.

Correcting for simultaneity is important in growth econometrics for our estimates to be consistent, hence the preferred use of the system GMM estimation[156]. The estimated coefficients are relatively well stable across a variety of estimation assumptions, alternative instruments and choices of control variables.

Table 3.4 summarizes the results of a series of robustness checks to alternative specifications both in the choice of control regressors, alternative specifications and instrument count. When changes in domestic capital are not explicitly accounted for in the estimation, the growth effects of human capital are significantly higher (see regression 1 and 2 in Table 3.4)[157]. However, once we account for changes in domestic and imported physical capital, the growth effect of human capital turns out relatively insignificant. Our results indicate it is important to disaggregate between changes in capital imports and domestic capital.

An important set of results in these robustness checks indicate that the growth effects of capital imports are insignificantly related to higher growth when regressions do not control for changes in trade policies and trade distortions. For example, when controlling for tariff rates, real trade openness and the level of total imports in goods and services, the growth effects of capital imports turn up significant. Moreover, once trade openness and tariffs are incorporated together, the estimation results indicate that both capital imports and human capital are significant drivers of higher growth in Latin America. These results also hold if we adopt the exogeneity assumptions of the regressors.

[156] Consistency implies the parameter estimate converge in probability to its true value (Heij et al., 2004).

[157] In regression (1) the ratio of capital imports in investment is defined as the ratio of machinery imports to total investment. See the data methodologies in section 3.3 and the Appendix A.6 for additional details.

Table 3.4

Robustness: alternative specifications

Dep. Var.: Real GDP Per Cápita Growth	Period: 1960-2010				
	(1)	(2)	(3)	(4)	(5)
Initial real GDP per cápita	-0.0105	-0.0149	-0.00751	-0.00852	-0.00321
	(0.0205)	(0.0120)	(0.0111)	(0.0192)	(0.0133)
Ratio of capital imports in investment	0.0651				
	(0.184)				
Capital imports		0.000755	0.00115	0.00115**	0.00164***
machinery imports growth		(0.000452)	(0.00101)	(0.000474)	(0.000591)
Domestic capital			0.000623	0.000658	0.000331
domestic capital growth			(0.00170)	(0.000916)	(0.000747)
Human capital	0.0779*	0.0605*	0.0311	0.0170	0.0573*
initial secondary school enrollment	(0.0416)	(0.0298)	(0.0738)	(0.0448)	(0.0328)
Investment share	0.000929	0.000866	0.00184	0.00187	0.000921
	(0.00104)	(0.000805)	(0.00214)	(0.00229)	(0.00204)
Population growth	0.000145	-0.000549	0.00306		0.00269
	(0.00948)	(0.00570)	(0.00915)		(0.0140)
Government consumption	-0.0272	-0.0113	-0.0110	-0.0144	-0.00305
	(0.0376)	(0.0161)	(0.0193)	(0.0225)	(0.0469)
Lack of price stability	-0.00199	-0.000953	-0.00245	-0.00771	-0.0324
	(0.0168)	(0.0111)	(0.0207)	(0.0174)	(0.108)
Macroeconomic crisis	-0.0221	-0.0208	-0.0106	-0.00788	0.00273
banking and currency	(0.0176)	(0.0162)	(0.0424)	(0.0322)	(0.0338)
Imports of goods and services				0.00176	
				(0.0305)	
Trade openness				-0.00479	-0.00831
				(0.0222)	(0.0319)
Tariffs					-0.000165
					(0.00163)
Constant	-0.190	-0.106	-0.0749	0.0231	-0.188
	(0.235)	(0.139)	(0.267)	(0.235)	(0.214)
<u>*Specification Tests*</u>					
i) *F*-statistic	0.00	0.00	0.00	0.00	0.00
ii) Serial Correlation					
Arellano and Bond AR(2)	0.58	0.48	0.71	0.27	0.66
iii) Hansen *J* statistic for instruments validity	0.84	0.93	0.66	0.94	0.47
iv) Difference-in-Hansen Statistic					
Lagged growth instruments	1.00	0.87	0.75	0.38	0.68
System GMM Instruments	0.66	0.97	0.66	0.86	0.47
Observations	152	149	149	73	148
Number of groups	31	30	30	28	29
Instrument count	32	27	26	28	28

Notes: System GMM estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections and period specific effects. Small sample adjustments with collapsed instruments have been performed in all the estimations. This table reports the t-test instead of the z-test and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: All variables are treated as endogenous, except the initial relative income which is assumed predetermined. Endogenous regressors use second lags for the first difference equation and first lags for the levels equation. Predetermined variables use first lags for the difference equation and contemporaneous first differences for the levels equation. Estimation (1) use an additional lag for both equations. Estimation (2) use an additional lag for initial output, domestic and imported capital. Standard errors are given in parenthesis. The specifications tests report the p-values.

***Significant at 1%, **Significant at 5%, *Significant at 10%.

Controlling for trade distortions in Latin America is important; hence our motivation to include whenever deemed appropriate controls for trade openness and tariffs rates[158]. Import substitution industrialization strategies (ISI) in Latin America relied heavily on the use of tariff rates and trade restrictions to promote inward development (Baer, 1984). Once these strategies were abandoned in the late 1980's in the search for outward oriented development (export-led growth), tariff and trade policies played a major role to restrict imports and encourage exports. Therefore, trade policies and restrictions have played a major role in the development process of the region.

Throughout our analysis we have control for periods of severe macroeconomic distress in the form of banking and currency crisis across all of our estimation. These crisis are believed to be highly correlated with the growth rates in these economies and therefore are always included as controls. We have also found appropriate to control for fiscal policy in the form of government consumption, and for monetary policy in the form of a lack of price stability or inflation control. These controls have proven to be key determinants of growth in Latin America across a variety of estimation.

Our motivation to additionally include controls for the total investment share and population growth is that these have been traditional growth determinants in growth econometrics. By accounting for the population growth rate we are accounting for the economics of demographics, as we allow population dynamics to play a role explaining growth performance in the region: An increase in population with human capital may drive faster growth by augmenting the productivity of labour and raising consumer demand, while countries characterized by raising population with low human capital may experience a deterioration in living standard and augmenting poverty and inequality. Controlling for the investment share allow us to capture how much investments in physical capital these economies undertake, as more capital is usually related to increases in production, countries that do not invest enough on physical capital may find themselves

[158] The main reason to not include a control for tariff rates in our baseline estimations is due to low data availability for the full sample of thirty-two countries (World Bank, 2013). However, given our limited data on tariffs, once these are incorporated the growth effects of capital imports turn up significantly higher. Hence our estimates are a conservative estimation of these effects.

relatively poorer and growing relative less than those who undertake higher investment programs.

We are not in favour of including additional control regressors in our estimations since it seems very likely that the instrument count will exceed the cross-sectional number of countries, hence decreasing the capacity of system GMM to digest endogeneity. We have chosen to select the most appropriate controls given our knowledge of the Latin America growth process and a number of studies in the literature closely related our research[159].

3.6 Conclusions

This chapter examines the growth effects of domestic and imported capital in Latin America. We found that countries in the region are able to grow faster by acquiring capital imports. The benefits of acquiring imported physical capital appears to be larger in low income countries. At higher income levels, these economies may grow faster via the accumulation of domestic physical capital.

Capital imports are suggested to be an important channel of technology diffusion between advanced economies and developing countries. We found a strong correlation between higher productivity growth and the acquisition of electrical and nonelectrical machinery imports. Our findings supports the view that technological change requires capital investments in order drive economic growth (Hercowitz, 1998).

We offer a new interpretation for the general documented fact that since the 1980's there have been a growth slowdown in the vast majority of the small developing countries in Latin America, with a tendency towards a faster growth at the start of the twentieth first century. First, we present statistical evidence which shows that today the vast majority of these economies are below a quarter of the United States per capita income. Second, we find evidence that countries in Latin America who were initially richer in 1970 acquired less capital imports and not invested enough in domestic human and physical capital formation, therefore contributing to

[159] See the works of De Gregorio (1992a), Astorga (2010), Paus et al. (2003), Paus (2004).

their growth slowdown. On the contrary, economies that were relatively poorer at the beginning, grew faster by acquiring machinery imports, however once their income levels improved, these did not invest enough in the development of domestic capital.

In terms of per capita income relative to the United States several countries in the region are today relatively worse off than in 1970. These economies appear to not have invested enough neither in capital imports nor in domestic human and physical capital. Without sufficient capital accumulation in the region, exogenous technological change seems to have failed to improve living standards.

The growth enhancing effects of capital accumulation are proposed to be as important as those provided by total factor productivity growth for these economies to grow faster. We do not generally advocate to the view that capital accumulation does not matter for long run growth, while growth and development is entirely driven by exogenous technological change. As Parente and Precott (2002) suggest, that view does not provide a meaningful economic policy advice. We advocate to the view that growth is endogenous, and hence affected by economic policies and institutional development of the type suggested by Rebelo (1991), Romer (1994), Lee (1995), North (1989, 1991, 1994) and Acemoglu et al. (2003).

Is important to mention that our findings do not suggest a total reliance on foreign technologies instead of domestic innovations to drive economic growth, as this will imply the same consequences for long run growth and development as those proposed by Singer (1950), Prebisch (1959) and Nurkse (1952). In the light of our findings, we suggest the following economic policy guidance for the region. First, deregulation of the international trade of capital and the dismount of import taxes and quotas for machinery imports and transport equipment. Second, sound fiscal and monetary policies that promote macroeconomic stability. Third, the development of institutional reforms that leads to maintain the security of property rights and the rule of law. Fourth, the creation of proper incentives for domestic innovation in new technologies via the development of licensing agreements and the creation of research grants for a wide variety of projects. Furthermore, these economies need to promote entrepreneurial activity by deregulating private monopolies and implementing anti-trust laws that promote competition and incentive the creation of efficient industries with lower production costs.

In our analysis human capital appears to have an insignificant effect on long run growth. Gutierrez (2005) has also found a similar result for the region. However, it would be misleading to suggest that human capital does not matter for economic growth. We interpret our findings as suggesting that these economies seems to have exhausted the benefits of secondary schooling education, or the quality of it is inferior to those of advance economies. Perhaps improvements in data for the proportion of the population with a university degree will strengthen the significance of human capital effect on economic growth in Latin America, as with the passage of time a vast proportion of the population have tended to complete secondary education.

The low income countries in the region need to invest relatively more in the acquisition of capital imports and foreign technologies, while improving human capital formation. These investments are necessary since these economies may lack the necessary means to promote domestic innovation. For the high income countries, efforts should be primarily devoted to improve the efficiency of domestic human and physical capital, as well as the creation of domestic technologies via domestic innovation. It seems plausible to suggest that domestic innovation in new technologies offer the most significant way to exceed the long run growth performance of the advance economies. A dependency to foreign technologies may only constraint relative income below that of industrialized nations.

There are several avenues for further research. A closer look needs to be taken at the relationship between human capital and economic growth in Latin America. Also, further research should aim to disclose macroeconomic data at the national accounts level for the vast majority of these economies in order to facilitate the implementation of growth accounting exercise for the region. In another direction, in terms of monetary policy, it is not completely clear whether these economies in periods of relatively low inflation can achieve higher growth rates, relative to period were inflation was modest and growth rates exceeded potential. Finally, more research should be devoted to the understanding of the factors that could drag domestic innovation and research in new technologies in the developing countries of Latin America, and how these economies may reduce their dependency to imported capital.

Chapter 4

Inflation thresholds and economic growth in Latin America

4.1 Introduction

The role of inflation on economic activity has been at the centre of the debate among the structuralist and monetarist schools of economic development in Latin America over the past century. The trade-offs between inflation and output growth has been a key factor determining the economic growth and development performance of the region. While the consensus among economist is that inflation is overall detrimental for economic activity, the disagreement starts with respect to the growth effects of inflation at low and moderate inflation rates.

The existing literature on inflation and economic growth remains under dispute with respect to whether low to moderate inflation rates may be necessary to achieve a sustainable output growth, and on whether price stability should be maintained at all times despite the potential output costs of disinflation. While some studies consider moderate inflation as having no effects on output growth, others suggests that low to moderate inflation rates may be conducive to economic activity[160]. This dispute concerning the growth effects of inflation has been essential in the debate among monetarists and structuralists schools of economic thought in Latin America, which are concerned with the role of inflation on economic growth and development performance in these economies[161].

The economic history of Latin America has documented cases of output growth with inflation and stable prices, as well as stagnation with price stability and inflation (Baer, 1967). The exact relationship between inflation and economic growth in the region has largely remained unclear[162]. The existing literature has largely focussed on the determination of the growth effects of inflation rather than determining whether the growth effects of inflation are equal across different inflation rates; as well as the level of inflation at which raising prices starts to distort economic activity. Conventionally, the debate among monetarists and structuralists have been oriented towards the first question related to the growth effects of inflation rather than discussing possible nonlinearities and threshold effects in the relationship.

In an important study of the region growth process, De Gregorio (1992a) examines 12 Latin American economies from 1950 to 1985 and concludes that overall inflation is detrimental for economic activity. More importantly, De Gregorio (1992a) is among the firsts to suggests a possible nonlinear relationship between inflation and economic growth in the region based on the observation that the growth effects of inflation may vary according to the sample of countries under study. In an extension of their analysis, De Gregorio (1992b, 1993) examines specifically inflation and economic growth in

[160] For a survey see McCallum (1990), Driffill et al. (1990) and Temple (2000).

[161] Despite the numerous distortions caused by inflation in terms of the productive allocation of resources, the structuralists viewed inflation as necessary initially to achieve a faster rate of economic growth due to the needs for investments and industrialization in these economies. Once growth resumes, then a series of economic reforms to address the nominal and real rigidities in these economies will result in output growth with price stability. On the contrary, the monetarists viewed low and stable prices as conducive to economic activity at all development levels regardless of these countries needs for industrialization, since in their view long-run growth and inflation were uncorrelated at all, except at very high inflation rates.

[162] The complexity of the region growth process has posed additional difficulties to the design of theoretical models of economic growth for the region (Arida, 1986).

these countries, and concludes that inflation is detrimental to output growth through its negative effects in the productive allocation of resources, and the accumulation and productivity of capital. A more recent study on the inflation-growth nexus for the region is that conducted by Bittencourt (2012) who examines four Latin American economies from 1970 to 2007, concluding that inflation exerts a negative effect on economic activity, and is a main determinant of economic growth in the region.

The view that inflation is detrimental for economic growth appears to be consensus nowadays in the literature[163]. What has received less attention are the potential nonlinearities and threshold effects in the inflation-growth relationship. The question of interest is at what level of inflation raising prices starts to be detrimental for output growth. The hypothesis of nonlinearities and threshold effect in the inflation-growth nexus gained recognition in the literature with the important contribution of Fischer (1993). In an examination of the maximum amount of countries for which data was available at the time from 1961 to 1988, Fischer (1993) concludes that across advanced and developing countries the relationship between inflation and economic growth is nonlinear. In fact, using a spline function approach, an inflation threshold was proposed to occur at a 15% and a 40% inflation rate[164]. A similar approach was follow by Sarel (1996), who examined 87 economies from 1970 to 1990 and concludes there is an overall structural break in the inflation-growth relationship occurring at an 8% inflation rate[165].

Other studies following the spline function approach are those of Christoffersen and Doyle (2000) who examines a panel of 22 economies in

---

[163] For a discussion see, for example, Wallis (1960), Seers (1962), Sidrauski (1967), Fischer and Modigliani (1978), Kormendi and Meguire (1985), Levine and Zervos (1993), Barro (1996), Judson and Orphanides (1999), Temple (2000) and Guerrero (2006).

[164] More importantly, Fischer (1993) suggests that the growth effects of inflation before the threshold are positive, while inflation rates exceeding the threshold have a clear detrimental effect on output growth.

[165] Another comprehensive study on inflation and economic growth nonlinearities was conducted by Ghosh and Phillips (1998) where 145 countries were examined from 1960 to 1996. Using a binary recursive tree methodology for threshold estimation, their results show a robust negative relationship between inflation and economic growth. In that order, their findings suggests that low inflation rates—around 3% per year—are positively correlated with higher growth.

transition from 1990 to 1997, finding evidence of an inflation threshold occurring at a 13% inflation rate. In addition, Burdekin et al. (2004) also finds evidence of an inflation threshold at a 3% inflation rate in a sample of 51 developing countries from 1967 to 1992. Their findings also suggests that while the total cost of inflation may increase after inflation has exceeded the threshold, the marginal cost of inflation decrease at higher inflation rates[166]. As in Sarel (1996), their findings suggest that not accounting for nonlinearities in the inflation-growth nexus may bias the estimates for the growth effects of inflation.

A key issue with the spline function approach is that the threshold is being specified by the researcher in the regression model rather than being estimated as a parameter of the model. Improving on this issue, Khan and Senhadji (2001) propose a non-dynamic panel threshold model to study nonlinearities and threshold effects in 140 countries from 1960 to 1998[167]. Their results situated the location of the inflation threshold to be approximately at 11% to 12% for developing countries. In addition, implementing a variation of the panel threshold methodology, Drukker et al. (2005) examines 138 economies over the period from 1950 to 2000, finding evidence of an inflation threshold located nearly at a 19% inflation rate.

In recent years there has been an active research in the field of inflation and economic growth nonlinearities. Espinoza et al. (2010) implements a Logistic Smooth Transition model (LSTR) to estimates inflation thresholds in a sample of 165 countries from 1960-2007. Their findings also suggest an overall inflation threshold at a 10% inflation rate, where there is a high speed of transition such that once the inflation threshold has been exceeded, inflation quickly have substantial detrimental effects on output growth. In an extension of the panel threshold models proposed by the statistical theory of Hansen (1999, 2000), Bick (2010) develops a static panel threshold model that accounts for regime specific intercepts and estimate the model for a sample of 40 developing countries from 1960 to 2004 finding evidence of a 12% inflation threshold when accounting for regime specific intercepts.

---

[166] A similar conclusion is suggested by Fischer (1993).

[167] Their non-dynamic panel threshold model is a modified version of the statistical theory for threshold estimation, testing and inference developed by Chan and Tsay (1998) and Hansen (1999, 2000).

A key limitation of non-dynamic panel threshold models is that in growth econometrics the bias caused by the endogeneity of initial income in the growth model can be substantial (Caselli et al., 1996)[168]. Improving on this limitation recently, Kremer et al. (2013) extends the Hansen (1999, 2000) statistical theory for threshold estimation, and the Caner and Hansen (2004) instrumental variables estimation procedures for a threshold, to develop a dynamic panel threshold model with endogenous regressors. The model is estimated using data from a 124 countries from 1950 to 2004, and their results suggests an inflation threshold of 2.5% for advanced economies and 17.2% for developing countries. Below the threshold inflation is found to be insignificantly correlated to output growth in the developing countries, with the corresponding negative growth effect when inflation exceeds the threshold level.

There are important limitations and caveats in existing studies of inflation and economic growth. An important branch of the existing literature do suggest that a long-run relationship between inflation and output growth is inexistent, as the evidence may crucially depends on very high inflation observations, the econometric specification, modifications in the sample of countries, and changes in the time period under examination (Levine and Renelt, 1992, Bullard and Keating, 1995, Clark, 1997, Bruno and Easterly, 1998). In addition, the existing literature has overlooked the potential role of fiscal policy on economic growth and inflation performance. Across many studies, fiscal policy is found to be an important driver of output growth and inflation across countries (Easterly and Rebelo, 1993, Fischer, 1993, Gavin and Perotti, 1997, Catão and Terrones, 2005, Cárdenas and Perry, 2011, Lin and Chu, 2013). In that order, not accounting for fiscal policy may possible

[168] In a recent study of nonlinearities and threshold effects in 44 economies from 1961 to 2007, López-Villavicencio and Mignon (2011) adopts a different approach to the standard Hansen (1999, 2000) statistical theory for threshold regressions, and implements a panel smooth transition regression model of type described by González et al. (2005), as well as a dynamic panel generalized method of moment estimation with quadratic terms in order to model nonlinearities. Their results also show that inflation has a nonlinear effect on economic growth, and their findings suggest a 17.5% threshold for developing countries. A notable result in their estimations is that below the threshold inflation does not significantly correlate with output growth. However, inflation rates exceeding the threshold have a detrimental effects on economic activity.

influence nonlinearities and threshold effects in the inflation-growth relationship.

The hypothesis of nonlinearities and threshold effects in the inflation-growth nexus has not received much attention in the existing literature on economic growth and development in Latin America. To the best of our knowledge, an exhaustive research on the different growth effects of inflation across varying inflation rates in Latin America have not been undertaken before, and remains an important gap in the existing literature that we intend to cover in this chapter. In addition, nonlinearities and threshold effects between inflation and economic growth have not been thoroughly examined in the context of the structuralist and monetarist view of inflation, economic growth and development in the region. Furthermore, neither has been examined the potential role of fiscal policy in the determination of inflation threshold in these economies.

In this chapter we examine nonlinearities and threshold effects in the inflation-growth nexus of 32 Latin American economies from 1960 to 2010. In addition, we also examine the role of fiscal policy in the determination of inflation threshold in the region. Unlike previous studies, rather than using a single threshold estimation approach we use different threshold estimation procedures for testing and inference. We implement a variant of the spline function approach for threshold estimation outlined by Sarel (1996) and Burdekin et al. (2004). In addition, we apply the cross-sectional and panel data threshold estimators proposed by Hansen (1999, 2000) where the inflation threshold is assumed unknown to the researcher, and is estimated as a parameter of the model. Furthermore, we also implement a dynamic panel data threshold model with endogenous regressors of the type described by Kremer et al. (2013).

Using different threshold estimation procedures allow us to account for the potential endogeneity of initial income in the growth model, as well as the possible endogeneity of inflation as threshold variable. We surpassed many of the limitations of existing studies on inflation and economic growth by focusing exclusively in the Latin American economies. In that order, we study in detail inflation and economic growth performance in these economies under different time windows along the period from 1960 to 2010. As the region provides evidence of inflationary episodes with stagnation and output growth, as well as periods of price stability with output growth and stagnation, our findings are found robust to the inclusion and exclusion of high inflation observations.

The main results of this chapter are summarized as follow. First, we document the existence of an inflation-growth nexus in Latin America. Second, we find significant evidence in favour of nonlinearities and threshold effects in the inflation growth relationship. The growth effects of inflation are unequal across varying inflation rates. Third, our results show evidence of an inflation threshold in Latin America located at a 14% inflation rate. Fourth, inflation lower than the threshold is found to have significant effects on output growth.

Fifth, inflation higher than the threshold has a strong detrimental effect on economic growth. Sixth, while controlling for high inflation observations, our findings suggest that low inflation countries may have a lower inflation threshold than high inflation countries. Seventh, accounting for fiscal policy and the money supply does not change the qualitative results of this chapter. In that order, our findings support the structuralist view of inflation for long-run growth and development in Latin America, as inflation performance may depend on structural socioeconomic rigidities in these economies aside to fiscal and monetary policy.

Eight, while we do not initially find significant evidence of cross-sectional correlation amid inflation and output growth, our findings suggests that once we control for fiscal policy, there is a correlation between inflation and economic activity in a cross-sectional setting. Ninth, our findings are robust to different econometric methods, additional explanatory variables, outlier's sensitivity, high inflation observations, variations in the number of countries and time periods under examination. Tenth, once accounting for the main determinants of economic policy and capital accumulation, our evidence suggests that by distorting the efficient allocation of resources and the productivity of capital, inflation higher than the threshold have a significantly negative effect on output growth.

The rest of this chapter is organized as follow. Section 4.2 discusses the role of inflation on economic activity, particularly in Latin America. Section 4.3 describes the methodology for the inflation-growth model, the inflation threshold estimation methods, and the data. Section 4.4 investigates the inflation-growth nexus, nonlinearities and threshold effects, as well as the role of fiscal policy on the determination of inflation thresholds in Latin America. Section 4.5 concludes. A further description of some of the methods used in the estimations, the list of countries and additional robustness checks are provided in appendices A and B.

4.2 The role of inflation on economic activity in Latin America

The trade-offs between inflation and output growth has been part of the economic history of Latin America over the past century and today. At the heart of the debate among the structuralists and monetarists schools of economic development are the explanations on the roots of inflation, its impact on economic activity and appropriate stabilization policies for the region. The empirical evidence has aimed to establish a definite link between growth and inflation that may guide economic policy to promote a sustainable economic growth and development with price stability. However, the output cost of disinflation has been substantial in Latin America. General increases in the price levels with modest per capita income growth rates has characterized the region since the 1950's (Furtado, 1965).

An important exploration on the complexities of the inflation-growth nexus in Latin America was undertaken by Baer (1967), and its conclusions largely remain valid as of today. The evidence may well provide cases of price stability with sustainable output growth and stagnation, as well as cases of sustainable growth with persistent inflation and price stability (Baer, 1967). While the empirical evidence has shed light on the roots of inflation, and proper stabilization policies, the nature of the relation between inflation and output growth has largely remained under dispute in the existing literature. In that order, the empirical evidence has remained inconclusive as to clarify at what level of inflation raising prices start to distort economic activity. In what follows we briefly review the causes of inflation in the region, and the theoretical and empirical literature on inflation and growth in Latin America.

The early debate among the structuralist and monetarist schools of economic development aimed primarily to study the nature of the relation between inflation and economic growth as one of the primary goals of economic policy in Latin America (Kay, 1991). According to the structuralists, inflation is primarily caused by structural and socioeconomic rigidities in these economies that should be addressed by inward-development industrialization policies. Among these structural and socioeconomic factors is an inelastic supply of agricultural products that given the growing demand of the population in the urban centres resulted in higher prices for the domestically produced agricultural products. In addition, the declines in the terms of trade also fuelled inflation via the raising prices of imported goods and services caused by an inelastic demand for imports in these economics. Moreover, inflation was driven by an expansionary fiscal policy derived from the growing demand for infrastructure originating from the rapid urbanization of the cities (Baer, 1967, Arndt, 1985, Di Filippo, 2009, Boianovsky, 2012). On the contrary, monetarists viewed inflation as resulting primarily from balance of payments difficulties, uncontrolled increases in the money supply, and the monetization of the fiscal deficit through the use of seigniorage revenue to finance unproductive government investment projects and consumption expenditures (Baer, 1967, Laidler, 1981).

To achieve a sustainable economic growth and development in the region—according to the monetarists—economic policy in these economies should aim to curtail unproductive government investments and consumption expenditures, increase taxes and improve tax collection, control the money supply, and adjust the exchange rates such that the trade balance and the balance of payments could stabilize. Moreover, the governments of these economies should focus their efforts in developing the comparative advantages of their countries. In that order, their strategy was an outward development approach oriented towards the development of the export sector.

Economic policy according to the structuralists should primarily address the main structural rigidities that cause inflation in these economies, that is, the limited agricultural production capacity, and the inelastic demand for imports. In that order, the structuralists advocate to agricultural reforms and the redistribution of the land. They also advocate to a strategy of import substitution industrialization that leads to inward development by curtailing the unnecessary importation of final goods and services. In addition, they advocate to the creation of fiscal incentives and subsidies for producer and entrepreneurs aiming at innovation and research of new technologies to develop new production methods to produce the goods and services that were being imported. In addition, there should be government intervention to protect the infant industries and develop the investment project where private capital could not initiate these. In that order, due to the expansionary fiscal and monetary policies, inflation will initially increase with output growth. However, at a later stage of development process—once internal markets have developed and the economic reform agenda implemented—then growth will decouple with inflation, and a sustainable output growth will resume with price stability.

Whether the structuralist or the monetarist approach to inflation has prevailed in Latin America is a subject of controversy in the existing literature. The fact is that both economic policy recipes has led to periods of severe macroeconomic crisis in the region. The shock therapy of the monetarist and curtailment of credit, government investments and currency devaluations to stabilize the public finances and the balance of payments have led to severe economic collapses, banking and currency crisis, and raising income inequality since the 1980's.

The structuralist policies failed to promote domestic innovation and research in new technologies, and therefore domestic producers could not managed to produce most of the goods and services that were being imported from abroad. In that order, the import coefficient was still substantial in Latin America despite import substitution industrialization, thus fuelling balance of payment crisis. The land reforms were unevenly implemented and were not successful in the promotion and diversification of the export goods. Government investments were mostly unproductive, thereby leading to fiscal deficits. The monetization of this deficit through money creation and public debt led to the debt crisis or "lost decade" of the 1980's.

The literature on inflation and economic growth outline various channels through which the growth effects of inflation may operate, aside those proposed by the structuralists and the monetarists[169]. First, inflation may affect economic activity by reducing the real deposit rates, savings and hence investment. Inflation may alter the composition of investment and increase uncertainty which may lead to reductions in physical and human capital accumulation. Raising prices can reduce households real money balances and increase the costs of money thereby leading to the unproductive allocation of

[169] For a discussion, see Temple (2000).

resources. Inflation may also affect growth may increasing the variability of relative prices, distorting the firm's allocation of capital and reducing firms profits. As in De Gregorio (1993), inflation may result from an inefficient tax collection system, and from the government use of seigniorage revenue to fund investment projects. In addition, inflation may disturb financial markets leading to inefficiencies in the credit market, augmenting the risk premium, affecting the valuation of companies, shortening the time horizon of contracts and affecting projects screening[170].

In our view, the major sources of inflation in the region are uncontrolled increases in the money supply, fiscal imbalances, the procyclicality of fiscal policy, and negative supply shocks mostly in the form of declining terms of trade[171]. In addition, we view inflation as mainly originating from structural and socioeconomic rigidities in these economies such as an inelastic supply of agricultural products, labour market frictions, a growing demand for infrastructure and investments in the urban centres, and social conflicts steaming from weak institutions that promote unproductive government subsidies and transfers thus further generating fiscal imbalances[172].

The existing literature on inflation and economic growth in Latin America, however, has not examined thoroughly nonlinearities and threshold effects in the inflation-growth nexus. We contribute to the existing literature by examining threshold effects and nonlinearities between inflation and economic growth specifically in the Latin American economies. Following Clark (1997) critique to studies of inflation and economic growth, we focus on the Latin American region thus defining precisely our sample of countries. In addition, we use different econometric methods and threshold estimation testing and inference procedures to study nonlinearities and threshold effects in the inflation-growth relationship of these economies across different time periods.

[170] For a discussion on the distinct channels through which inflation may affect output growth see also Fischer and Modigliani (1978) and Fischer (1983).

[171] For a detailed discussion on the sources of inflation in the Latin America economies see Baer (1967), De Gregorio (1993) and Gavin and Perotti (1997).

[172] Also on these issues, see the works of Fischer and Mayer (1980), Kay (1991), Franko (2007), Boianovsky (2012) and Bittencourt (2012).

4.3 Threshold effects in inflation-growth models: methodology and data

The empirical literature on economic growth builds on the growth models developed by Barro (1991), Mankiw et al. (1992), Knight et al. (1993) and Caselli et al. (1996). Conventionally, in these classes of models the growth rate of real GDP per capita is regressed against the main growth determinants and a standard set of control regressors[173]. Building on this literature, the subsequent studies on economic growth specify and estimate cross-country growth regressions to determine the direction and statistical significance of the correlations between the macroeconomic variables and output growth[174]. In that order, the determination of relevant empirical and theoretical growth determinants may guide macroeconomic policy to achieve a sustainable output growth to promote economic development (Fischer, 1991).

In a pioneering piece of work to examine the determinants of economic growth in a cross-section of 47 countries during the post-war period from 1950 to 1977, Kormendi and Meguire (1985) establishes the baseline cross-country growth regression model for cross-sectional studies of economic growth. In their specification they regress real output growth against a set of key growth determinants. In accordance with neoclassical growth theory, their results show that economic growth is negatively related to the level of initial income per capita and to the population growth rate. In addition, they suggest that inflation is negatively related to output growth.

To analyse the robustness of cross-country growth regressions to changes in the conditioning set of information or explanatory variables, Levine and Renelt (1992) extend Kormendi and Meguire (1985) and use Leamer (1983) extreme bound analysis in a sample of 119 countries from 1960 to 1989 to test whether the macroeconomic variables suggested by the theoretical literature are significantly correlated with long run averages of per capita growth rates.

---

[173] For an extensive discussion on the theoretical foundations and mechanics of empirical growth models see, for example, Durlauf et al. (2005) and Acemoglu (2009).

[174] Note that, conventionally, cross-country growth regression models do not establish a structural model of economic growth, but rather examine partial correlations between the growth determinants and long run averages of per capita growth rates.

Their main interest is on whether the macroeconomic factors remain significantly correlated with economic growth at convention levels of statistical significance, and with the predicted correlation sign suggested by macroeconomic theory when the set of explanatory variables are modified. Their results show that few macroeconomic variables stand the sensitivity analysis and there is no consensus theoretical model to guide empirical studies of economic growth. Among their findings, they also suggest that the investment share to GDP is significantly correlated with output growth while trade policy measures and fiscal indicators are not robustly correlated with economic growth.

In a study concerning the macroeconomic determinants of economic growth in twelve Latin American countries from 1950 to 1985, De Gregorio (1992a) implements growth accounting and cross country growth regressions methods to conclude that factor productivity, human and physical capital investments, and political stability are significant determinants of output growth in Latin America. In contrast, government consumption and inflation are found to be negatively related to output growth while the terms of trade and trade openness do not have significant effects on economic activity.

4.3.1 Theoretical foundations of inflation-growth models

For an examination of inflation and economic growth performance in the Latin American economies, De Gregorio (1993) developed two endogenous growth models where inflation and taxes are the main determinants of long run growth rates in Latin America[175]. The first of these models is characterized by a three sector economy—government, firms and households—where inflation is assumed exogenous, there is no international capital mobility and the production technology exhibits constant return to scales where capital is the only factor of production[176]. Under this setting, inflation reduces output growth via a reduction in the firm investments in new capital. Within the model, the price of the new capital good is composed by the market price plus a transaction cost of holding money to buy this new

[175] These models feature some of the characteristics and mechanics of the canonical endogenous growth models developed by Romer (1986) and Rebelo (1991).

[176] Inflation is assumed as anticipated in the model.

capital. In that order, an exogenous increase in inflation raises the transaction cost of holding money thereby increasing the price of the new capital good, and reducing the real money balances of the firm available to invest thereby reducing the firm's investments in new capital. At the equilibrium, the exogenous increase in inflation reduces the growth rate of capital and output via a reduction in the investment rate of the firm.

The second endogenous growth model extends the previous analysis to the cases where inflation affects the productivity of capital and household behaviour. In this new setting, the productivity of capital crucially depends on the level of employment. In addition, while household behaviour was unaffected by inflation in the first model, in the extended version households chooses between money balances, consumption and leisure. In that order, an exogenous increase in inflation raises the price of the consumption good via an increase in the inflation tax, thereby augmenting leisure and hence reducing employment and the marginal productivity of capital[177]. The reaction of the firm is also a decrease in the investment rate caused by declines in employment via reductions in the labour demand of the firm. In the event of inflation, the firm faces increased labour costs derived from raising wages, therefore labour demand and hence employment also decreases. The declines in both the labour demand of the firm, and the labour supply of the households, leads to lower employment, lower marginal productivity of capital and a lower investment rate. In that order, at the equilibrium, the exogenous increase in inflation reduces the rate of output growth via the reduction in employment, the rate of investment and the marginal productivity of capital.

A third channel through which inflation may affect the growth rate of output is through the government budget financing and seigniorage. Primarily extending its first theoretical model, De Gregorio (1993) assumes inflation as part of a public finance problem. In this modified version, the government objective is to maximize the growth rate of consumption while

[177] Note that in the model the price of the consumption good is composed by the market price plus the transaction cost of holding money. In the event of inflation, an increase in nominal interest rates reduces real money balances thereby raising the cost of holding money and increasing the price of the consumption good. In that order, households substitute from consumption to leisure and therefore employment is reduced thereby reducing the marginal productivity of capital.

financing its budget through an income tax—which crucially depends on collection costs—and the rate of money creation. Given this setting, output depends on inflation and the income tax, where an increase in tax collection inefficiencies leads to inflation and consequently reduces the growth rate of output.

Following Kormendi and Meguire (1985) and Barro (1991), De Gregorio (1993) implements cross-country growth regressions in a sample of 12 Latin American economies from 1950 to 1985 to determine whether the growth effects of inflation operates through the investment or the efficiency of investment channel[178]. The results show that inflation has negative effects on economic growth primarily by reducing the efficiency of investment. However, while the theoretical model predicts that inflation affects the productivity of capital through its effect in the employment ratio, inflation and employment appear weakly related. In addition, inflation appears uncorrelated with the broad measure of investment. The findings also suggest that inefficient tax systems and fiscal imbalances may be the main drivers of high inflation in Latin America. In a similar study about the growth effects of inflation, De Gregorio (1992b) also found that inflation negatively affects output growth mainly by reducing the productivity of capital rather than by reducing the rate of capital accumulation.

While De Gregorio (1993) found some preliminary empirical evidence of nonlinearities in the inflation-growth nexus, a mayor limitation of traditional inflation-growth models is that by assumption the growth effects of inflation are assumed linear, that is, the growth effects of inflation are identical across all inflation rates. Relaxing this linearity assumption is a major motivation for introducing threshold effects and nonlinearities in the inflation growth nexus (Fischer, 1993). In addition, there are numerous channels aside that of investment and the productivity of capital through which inflation may influence economic activity[179].

---

[178] The empirical application of De Gregorio (1993) is not completely derived from its theoretical growth model. It is actually a simplified version of the model that follows the mechanics for growth econometrics.

[179] Among these other channels are uncontrolled increases in the money supply, fiscal imbalances and structural rigidities (Baer, 1967, Friedman and Allen, 1970, Kay, 1991, Gavin and Perotti, 1997, Franko, 2007).

Our baseline specification for the Latin America inflation-growth model follows that of De Gregorio (1993). However, rather than determining the channels through which inflation may influence economic growth, our focus is primarily on the determination of the magnitude and direction of the correlation between inflation and growth. Namely, our interest relies on the growth effects of inflation while controlling for key macroeconomic factors. For this aim our specification considers as a key growth determinant the investment share to GDP in order to account for the growth effects of inflation operating through the channels of the productivity of capital and its rate of accumulation.

For ease of exposition, we initially leave aside fiscal policy issues until later on when we introduce fiscal measures to the model in order to account for the possibility that inflation may be operating through the channels of fiscal policy. Monetary issues are left aside due to the high correlation between money growth and inflation. As Friedman and Allen (1970) pointed out, inflation may result from increases in the quantity of money that exceed increases in output. Therefore, since our interest relies on the growth effects of inflation rather than in the causes of inflation, we essentially focus on controlling for the main growth determinants through which the growth effects of inflation may primarily operate. In what follows we develop the baseline inflation-growth model for the Latin American economies, and the estimation methodology for testing and inference of threshold effects within the model.

4.3.2 Inflation-growth model

To examine the role of inflation performance on economic growth in Latin America we estimate the following dynamic panel cross-country growth model:

$$dlny_{i,t} = \beta' \Pi_{i,t} + \delta' Z_{i,t} + \mu_t + \eta_i + e_{i,t} \tag{4.1}$$

where the dependent variable $dlny_{i,t}$ denotes the growth rate of real GDP per capita[180]; $\Pi_{i,t}$ is an inflation function; $Z_{i,t}$ is a k-vector of control variables; μ_t and η_i are respectively the time and country specific effects; $e_{i,t}$ denotes the country specific term. The panel dimensions are $i \in [1, \dots, 32]$ Latin American

[180] Note that the growth rate is calculated by logarithmic differences.

economies across $t \in [1, \ldots, 10]$ five years averages over the period from 1960 to 2010[181]. The subscript i and t denotes respectively the number of countries and time period.

The inflation function is defined as a semi-log transformation of the inflation rate (Khan and Senhadji, 2001, Drukker et al., 2005, Kremer et al., 2013):

$$\Pi_{i,t} = \begin{cases} \pi_{i,t} - 1 \; if \; \pi_{i,t} \leq 1 \\ \ln(\pi_{i,t}) \, if \; \pi_{i,t} > 1 \end{cases}$$

where $\pi_{i,t}$ denotes the inflation rate. This function offers two main advantages. First, it allows the inclusion of negative inflation rates within the model. The function introduces continuity at the unity point where the function transition from being linear to log linear (Khan and Senhadji, 2001). Second, the log linear part of the function reduces the distortion that high inflation observations may cause in the estimation results (Ghosh and Phillips, 1998).

The β coefficient of the inflation function ($\Pi_{i,t}$) denotes the growth effects of inflation on economic activity. Our hypothesis is that this coefficient is sizable, statistically different than zero, and negative. A negative inflation function coefficient may reflect the fact that inflation has detrimental effects on output growth. The opposite will hold if the coefficient turns out positive. In contrast, a coefficient that is statistically equal to zero may suggest that inflation and output growth are not correlated, and hence the growth effects of inflation are potentially statistically insignificant.

The standard vector of control regressors or explanatory variables includes the initial income level, the investment share to GDP, the population growth rate, the terms of trade growth and volatility, and the trade openness growth and volatility (Kormendi and Meguire, 1985, Levine and Renelt, 1992, Burdekin et al., 2004, Drukker et al., 2005, Kremer et al., 2013). Following Durlauf et al. (2005), we include time and country specific effects to control for common shocks and unobserved heterogeneity that may affect the Latin American economies. In addition, as is standard in cross-country growth regressions, we use five-year averages of the variables time series to control for business cycles fluctuations (Islam, 1995).

[181] See Appendix A.1 for the list of Latin American countries.

For the estimation of Eq. (4.1) we adopt a three step estimation strategy. First, we estimate the model via the pooled ordinary least squares estimator with time invariant specific effects under the assumption of no country specific differences among the Latin American countries. The second step control for unobserved heterogeneity and country specific effects in a within-groups estimation of Eq. (4.1). Finally, we control for the potential endogeneity of the initial income in a two-stage least squares fixed-effects instrumental variables estimation. These different econometric methods should yield similar inference results about the growth effects of inflation on economic activity.

The two-stage least squares estimates of Eq. (4.1) are obtained through the Schaffer (2012) program for instrumental variables estimations. To address the potential endogeneity of initial income within the model we use lagged levels of initial income as instruments (Barro and Sala-i-Martin, 2004)[182]. Across all the estimations the reported statistics are heteroskedasticity and autocorrelation consistent (HAC)[183]. For the pooled OLS and within-groups estimations we use clustered-robust standard errors (Arellano, 1987, Froot, 1989, Rogers, 1994, Williams, 2000, Stock and Watson, 2008). For the two-stage least squares estimates we use HAC standard errors calculated using the Barlett kernel with Newey and West (1994) fixed bandwidth rule (Baum et al., 2007).

Instrumental variables specification tests are reported to verify the validity of all the instruments used in the two-stage least squares estimations[184]. The first of these tests is the Kleibergen and Paap (2006) *rk* LM statistics for underidentification. The null hypothesis is that the estimated equation is underidentified, that is, the instruments used are not correlated with the endogenous regressor. If the instruments were to be found uncorrelated with the endogenous regressors, then the instrumental

---

[182] Note that since economic growth is defined as the growth rate of GDP per capita by logarithmic differences, then initial income is a lagged dependent variable and endogenous regressor in the model. This endogeneity issue motivates the implementation of instrumental variables estimations for Eq. (4.1).

[183] We find some evidence that standard errors are not independently and identically distributed (iid) in the preliminary estimations of Eq. (4.1), therefore our choice of HAC standard errors.

[184] For a detailed review of instrumental variables specification tests see, for example, Murray (2006) and Baum et al. (2007).

variables estimations could be biased, and the estimation bias could approximate that of ordinary least squares (OLS) estimations (Hahn and Hausman, 2002). Rejecting the null hypothesis indicates that the model is correctly specified and the estimated equation is identified (Kleibergen and Schaffer, 2013)[185].

When there is a weak or small correlation among the instruments and the endogenous regressors then a problem of weak identification arises. In the presence of weak instruments the two-stage least squares estimates are also biased in finite samples and standard errors tend to be small (Murray, 2006). To test for weak identification in the context of heteroskedasticity, serial correlation or clustering of the errors we implement the Kleibergen and Paap (2006) *rk* Wald F statistic given Stock and Yogo (2005) critical values for the size of the coefficient's Wald test in the two-stage least squares estimates[186]. The null hypothesis is that the selected instruments are weak against the alternative that these are strong, that is, strongly correlated with the endogenous regressors.

Instruments are defined to be weakly correlated with the endogenous regressors if the maximal size distortion of the coefficient's Wald test does exceed a certain threshold, for example 10%, when the actual rejection rate should be, for example, the standard 5% (Stock and Yogo, 2005). If the null hypothesis of weak identification is rejected then instruments are strongly correlated with the endogenous regressors. As an alternative test for weak identification we also implement the Staiger and Stock (1997) "rule of thumb" for the F-statistic. This rule suggests that the F-statistic should exceed the

[185] The implementation of the Kleibergen and Paap (2006) *rk* LM statistics is motivated by the assumption that the errors are not usually assumed identically and independently distributed (iid) in dynamic panel data estimations. If the iid assumption were to be imposed on the errors, then the corresponding alternative underidentification tests are the Anderson (1951) correlation test and the Cragg and Donald (1993) Wald F statistic.

[186] While Stock and Yogo (2005) calculated the critical values for the Cragg and Donald (1993) Wald F statistic under the iid assumption of the errors, we use the heteroskedasticity and autocorrelation consistent Kleibergen and Paap (2006) *rk* Wald F statistic under identical critical values. The Kleibergen and Paap *rk* Wald F statistic is the robust alternative to the Cragg and Donald Wald F statistic in the presence of heteroskedasticity, serial correlation or clustering in the residual term (Baum et al., 2007).

value of 10 for instruments to be considered strongly correlated with the nuisance parameters (Baum et al., 2007).

To test for the validity of the instruments set we implement the Hansen (1982) J test of overidentifying restriction under the null of instruments validity, that is, the selected instruments are uncorrelated with the residual term. If instruments are valid these are likely to be strongly correlated with the endogenous regressors, and the model correctly specified and identified. In addition, we also implement the endogeneity test proposed by Baum et al. (2003, 2007) under the null hypothesis that the suspected endogenous regressors can actually be treated as exogenous variables. A rejection of the null hypothesis of exogeneity motivates the implementation of instrumental variables estimations to address the endogeneity of some of the regressors in the model. If regressors are found to be exogenous then other estimation methods such as pooled OLS or within-groups estimations will perform better than two-stage least squares estimations.

The three step estimation strategy should produce similar inference result if the model of Eq. (4.1) is correctly specified and the regressors included in the model are relevant to explain economic growth and inflation in Latin America. A limitation of our approach is that by construction the growth model of Eq. (4.1) implicitly assumes that the growth effects of inflation are identical across all inflation rates. However, a branch of the literature suggest the possibility of different growth effects of inflation at different inflation rates (Fischer, 1993, Sarel, 1996). Intuitively, economic activity in low inflation countries may react differently to additional inflation than to high inflationary episodes. To address the issue of nonlinearities and threshold effects in the inflation-growth nexus, in what follows we describe the specifications and estimation methodologies for threshold regressions.

4.3.3 Spline function model

The inflation stabilization programs implemented in Latin America during the 1970’s and 1980’s provided different experiences where some of these economies where able to maintain moderate growth rates despite double digit inflation. However, during the 1990’s a few of these countries manage to achieve low and stable inflation rates at the expense of curtailing economic growth. In that order, an economy may exhibit periods where moderate growth may coexist either with high or low levels of inflation.

In a study concerning inflation and long run growth in Latin America, De Gregorio (1993) finds preliminary evidence in favour of nonlinearities in the inflation-growth nexus. The marginal costs of inflation may increase at higher inflation rates. In that order, the relationship between inflation and economic growth may be better approached as nonlinear. For this aim, a spline function model can be specified to study whether nonlinearities exist in the inflation-growth nexus.

An initial exploration in the study of nonlinearities in the relationship between inflation and economic growth was conducted by Fischer (1993) following the spline function approach described by Greene (1993). Using a sample of all the countries for which there was data available at that time, Fischer (1993) estimate a two knot spline function model, and finds that the growth effects of inflation are nonlinear, and the relationship between inflation and economic growth weakens at higher inflation rates[187]. The coefficient for the inflation threshold or knot was found to be statistically significant at conventional levels.

A similar approach to study nonlinearities in the inflation-growth nexus was undertaken by Sarel (1996) where a single knot spline function regression is estimated using a sample 87 countries from 1970 to 1990[188]. Their results show a statistically significant structural break or knot at an 8% inflation rate. Once inflation has exceeded the threshold, inflation is found to exert negative and statistically significant effects on economic growth. In a study examining 119 countries from 1959 to 1992 using spline function regressions, Judson and Orphanides (1999) finds that inflation is insignificantly negatively correlated with growth at single digit inflation rates, while the growth effects of inflation turns out significantly negative once inflation reaches double digits rates[189]. Examining separately a sample of 21 advanced countries from 1965-1992 and 51 developing countries from 1967-1992, Burdekin et al. (2004) estimate a three knot spline function and

[187] Fischer (1993) specifies two knots at a 15% and 46% inflation rates.

[188] In spline function models the selection of a single or multiple knots is mostly data based.

[189] Their spline function approach follows that of Fischer (1993), however they use two knots at a 10% and 40% inflation rate.

finds a 8% inflation threshold for advanced economies and a 3% threshold for developing countries. For the developing countries their results also suggest the presence of threshold effects at the prohibitively high inflation rates of 50% and 100%.

In this chapter we use an updated variant of Fischer (1993) and Sarel (1996) spline function regression approach following Greene (2012) and Burdekin et al. (2004). In particular, we estimate a single knot spline function model of the form[190]

$$dlny_{i,t} = \alpha + \beta_1 \Pi_{i,t} + \beta_2 q_{i,t}(\Pi_{i,t} - \tau) + \delta' Z_{i,t} + \mu_t + \eta_i + e_{i,t} \tag{4.2}$$

where $dlny_{i,t}$ denotes the growth rate of real GDP per capita; $\Pi_{i,t}$ denotes the inflation function; $Z_{i,t}$ is the a k-vector of control regressors previously defined in Eq. (4.1); μ_t and η_i are the respective time and country specific effects; $e_{i,t}$ denotes the country specific term. The panel dimensions are $i \in [1, \ldots, 32]$ Latin American economies across $t \in [1, \ldots, 10]$ five years averages from 1960 to 2010. The subscript i and t denotes respectively the number of countries and the time period. In addition, let

$$q_{i,t} = \begin{cases} 1 \; if \; \Pi_{i,t} \geq \tau \\ 0 \; if \; \Pi_{i,t} < \tau \end{cases}$$

where $q_{i,t}$ is an indicator variable which takes the value of 0 when inflation is below the threshold (τ) and the value of 1 when inflation exceeds the threshold. The incorporation of multiple thresholds to the spline function equation follows a similar procedure[191].

The spline function Eq. (4.2) allows for a single knot or threshold where the threshold variable is the inflation rate[192]. When the inflation function (Π)

[190] In an examination of the data for the Latin American economies—see Figure 4.1—we do not find sufficient evidence in favour of multiple thresholds in the inflation-growth of the Latin American economies. Nevertheless, as robustness, we also specify and estimate a two-knot spline function regression model as described in Appendix A.5. Our results show no significant statistical evidence in favour of a second threshold in the relationship between inflation and economic growth in Latin America. These additional results are available from the author upon request.

[191] See Appendix A.5 for a complete derivation of the spline function equation with multiple knots.

[192] The terms knot and threshold are used indistinctly (Greene, 2012).

is below the threshold (τ), the indicator variable q takes the value of zero and hence the β_1 coefficient measures the growth effects of inflation. When inflation exceeds the threshold, the indicator q takes the value of one and the growth effects of inflation are now measured by the sum of the β coefficients. In that order, the β_2 coefficient denotes the marginal growth effects of inflation once inflation exceeds its threshold. In addition, the t-statistic of the β_2 coefficient determines whether or not the inflation threshold is statistically significant at conventional levels (Fischer, 1993, Sarel, 1996).

The search procedure for the structural break in the inflation-growth nexus is data based. Following Burdekin et al. (2004), we estimate Eq. (4.2) via the within-groups estimator while iterating for different inflation rates within the range: 1% to 50% inflation rates[193]. The iteration start sequentially for inflation rates beginning at 1%, then to 1.5%, 2%, and so forth, augmenting each rate by a half percentage point[194]. We then proceed to choose as point of structural break the inflation rate that minimizes the sum of squared residuals or that maximizes the adjusted R-squared of the model[195]. The spline function knot or threshold value is then selected as the inflation rate where the structural break occurs. Following this procedure, the statistical significance of the threshold is determined by the t-statistic of the β_2 coefficient in the spline function equation.

After the search procedure for the threshold has been completed, we follow the three step estimation strategy described previously in order to determine whether the threshold value is statistically significant at conventional levels while accounting for unobserved heterogeneity, the endogeneity of the initial income, and controlling for high and influential inflation observations. A key

---

[193] Note that Burdekin et al. (2004) uses the generalized least squares (GLS) estimator with fixed effects for annual data in their sample of countries. Given our data structure for Latin America, we propose the use of the within-groups estimator with fixed effects using five-year averages of the variables time series (Sarel, 1996).

[194] Following Cagan (1956) definition of hyperinflation, we do not consider in this model the implausibly high inflation rates that exceed 50% as these may indicate a condition of hyperinflation crisis in these economies. In fact, the threshold for inflation crisis has been defined much lower in recent years. Reinhart and Rogoff (2009) define the beginning of an inflation crisis starting at an inflation rate of 20%. Therefore, adding these high inflation observations to the model may drive the results towards a negative relationship between inflation and growth (Bruno and Easterly, 1998).

[195] See Sarel (1996) for a similar approach. Note that these procedures assume that the error variance of the model remains constant across different inflation rates.

limitation of spline function models is that although the search for the threshold is data based, the threshold value is specified in an *ad hoc* fashion in Eq. (4.2) rather than being determined endogenously by the model. This implies that the researcher should have an a priori knowledge of location of the threshold. When the location of the threshold is unknown to the researcher, then an alternative threshold estimation method is needed.

4.3.4 Cross-sectional and panel threshold models

The hypothesis that the growth effects of inflation are unequal across different inflation rates is empirically relevant. In this case there may be a sample split based on inflation for which the regression model differs for different subsamples of the data. When the threshold value at which the sample split occurs is unknown to the researcher, the threshold parameter is unidentified and cannot be estimated using conventional statistical methods.

Let us consider the following inflation-growth model

$$dlny_i = \beta_1' Z_i + e_i \qquad \Pi_i \leq \tau \tag{4.3}$$

$$dlny_i = \beta_2' Z_i + e_i \qquad \Pi_i > \tau \tag{4.4}$$

where $dlny_i$ denotes the growth rate of real GDP per capita; Z_i is a k-vector of control regressors; Π_i is the inflation function and threshold variable; τ denotes the threshold parameter. The cross-sectional dimension is $i \in [1, \dots, 32]$ Latin American economies where the subscript i denotes the number of countries. The model considers a discontinued sample split based on the inflation function.

To combine the previous models—Eq. (4.3) and Eq. (4.4)—into a single equation, a threshold effect is defined as $\lambda_n = \beta_2 - \beta_1$. In that order, we estimate the following reduced-form inflation threshold model

$$dlny_i = \beta_2' Z_i + \lambda_n' Z_i \{\Pi_i \leq \tau\} + e_i \tag{4.5}$$

where $\{\Pi_i \leq \tau\}$ is an indicator function which is true if inflation is below the threshold and false otherwise. Our interest is on the estimation of the parameters $(\beta_2, \lambda_n, \tau)$ which may differ based on the threshold variable. For this aim, an statistical theory and least squares estimation procedures are developed by Hansen (2000) for threshold estimations in equations of the type of Eq. (4.5). In particular, we focus on the estimation of the threshold parameter ($\hat{\tau}$) which is unknown a priori and hence to be estimated as a parameter of the model.

The estimation procedure considers the threshold effect (λ_n) as converging to zero as the sample size (*n*) increase while β_1 approach β_2 which is hold constant. The least-squares estimates are then easily obtained by concentration. In that order, the asymptotic distribution of the threshold estimate ($\hat{\tau}$) is nonstandard and free of nuisance parameters. Following Hansen (2000), the concentrated sum of squared errors for the least squares estimates of Eq. (4.5) can be specified as $S_n(\tau) = S_n\left(\hat{\beta}_2(\tau), \hat{\lambda}(\tau), \tau\right)$. In this case, the estimated threshold parameter ($\hat{\tau}$) is the value that minimizes this expression and therefore is defined as

$$\hat{\tau} = argmin_{\tau \in T_n} S_n(\tau)$$

The minimization procedures assumes the threshold to be limited to the set $[\underline{\tau}, \overline{\tau}] = \Gamma$ where $\Gamma_n = \Gamma \cap \{\tau_1, \tau_2, \tau_3, \dots, \tau_n\}$. In that order, as the sample size increase the set Γ can be approximated by a grid search over the possible threshold values within this bounded set. The parameters $(\widehat{\beta_2}, \hat{\lambda})$ can be estimated as $\widehat{\beta_2} = \widehat{\beta_2}(\hat{\tau})$ and $\hat{\lambda} = \hat{\lambda}(\hat{\tau})$ following the least squares estimation procedure.

A key issue in this type of models is whether the estimated threshold is statistically different than zero. To test for the statistical significance of the threshold we implement the heteroskedasticity-consistent Lagrange multiplier for a threshold developed by Hansen (1996). Under the null hypothesis of no threshold effects ($\beta_1 = \beta_2$) the estimated threshold ($\hat{\tau}$) is not identified and has a nonstandard distribution as the threshold parameter does not enter the regression under the null hypothesis. This pose additional difficulties to the testing procedure as critical values cannot be calculated in this scenario. However, Hansen (1996) shows that an asymptotically valid bootstrap procedure can be used to simulate the distribution of the test and obtain the *p*-values in order to test the hypothesis[196]. A rejection of the null

[196] Since we find some evidence in favour of heteroskedasticity in the data we prefer to use the Hansen LM test for threshold effects. For a more detailed

follows if the calculated p-values fall below conventional levels of statistical significance.

To obtain the threshold estimates confidence intervals a scaled likelihood ratio statistic (*LR*) is proposed by Hansen (2000)[197]. Under the null hypothesis that the estimated threshold converges to its true value, namely that H_0: $\tau = \hat{\tau}$, the likelihood ratio test is defined as:

$$LR_n^*(\tau) = \frac{S_n(\tau) - S_n(\hat{\tau})}{\hat{\sigma}^2 \hat{\eta}^2}$$

where $S_n(\tau)$ is the sum of squared errors (SSR) when the null hypothesis is true (H_0: $\tau = \hat{\tau}$), while $S_n(\hat{\tau})$ is the SSR under the alternative; $\hat{\sigma}^2$ denotes the residual variance and $\hat{\eta}^2$ is a nuisance parameter. The heteroskedasticity-robust confidence region for the threshold is defined as $\hat{\Gamma}^* = \{\tau: LR_n^*(\tau) \leq c\}$ where *c* is the calculated critical values derived from the confidence level for the threshold parameter[198]. Given the assumption that the threshold effect (λ_n) converges to zero as the sample size increase, the confidence interval is asymptotically valid and critical values are obtained by inverting the *LR* statistic (Hansen, 2000). An intuitive figure can be draw plotting $LR_n^*(\tau)$ against possible threshold values, where the statistically significant least squares estimate of the inflation threshold ($\hat{\tau}$) is the value that minimizes the $LR_n^*(\tau)$ series and falls below the calculated critical values (*c)*.

This class of threshold models assumes the threshold as an exogenous variable that has a continuous distribution which is stationary. In addition, the model allows for a single threshold specification. Following the empirical application of Hansen (2000), we initially estimate the threshold model for a cross section of Latin American countries where the variables are long-run averages over the sample period from 1970 to 2010[199]. The set of control regressors is identical to one previously defined in Eq. (4.1) except that—as in

description of the threshold testing procedure and bootstrap methodology see Hansen (1996, 2000).

[197] The likelihood ratio statistic is robust to the potential heteroskedasticity in the residuals of the model.

[198] The asymptotic confidence level is conventionally 95% in this type of models.

[199] This sample period was chosen due to data availability as the statistical coverage of most Latin America countries is more complete since the 1970's.

the spline function model—it excludes the level of initial income since these methods does not handle lagged dependent variables within the model.

Although the Hansen (1996, 2000) threshold estimation procedures are conventionally specified for either time series or cross-sectional observations, following Hansen (1999), we also estimate an alternative panel data representation of Eq. (4.5) considering a pooled least squares specification overlooking time specific effects[200]. In particular, we estimate the following non-dynamic panel threshold model:

$$dlny_{i,t} = \beta_1' Z_{i,t} I(\Pi_{i,t} \leq \tau) + \beta_2' Z_{i,t} I(\Pi_{i,t} > \tau) + \eta_i + e_{i,t} \tag{4.6}$$

where $dlny_{i,t}$ denotes the growth rate of real GDP per capita; $Z_{i,t}$ is a k-vector of control regressors; the term $I(\cdot)$ is an indicator function where $\Pi_{i,t}$ denotes the inflation function as threshold variable, and τ is the threshold parameter[201]; countries specific effects are represented by η_i while $e_{i,t}$ denotes the country specific term. The β's coefficients represent respectively the growth effects of inflation below and above the threshold (τ). The panel dimensions are $i \in [1, \ldots, 32]$ Latin American economies across $t \in [1, \ldots, 10]$ five years averages from 1960 to 2010. The subscript i and t indexes respectively the number of countries and the time periods.

The vector of control regressors ($Z_{i,t}$) is standard, and includes the investment share to GDP, the population growth rate, the terms of trade growth and volatility, and the trade openness growth and volatility (Khan and Senhadji, 2001, Burdekin et al., 2004, Drukker et al., 2005). The panel threshold model is said to be non-dynamic as the set of control regressors excludes the level of initial income as an explanatory variable.

[200] In a similar application of these methods to panel data, Giuliano and Ruiz-Arranz (2009) apply the Hansen (2000) threshold estimation procedures to a panel spanning nearly 100 countries from 1975-2002 in order to examine the relationship amid remittances, growth and financial development. Using financial development as threshold variable, their results show that remittances leads to higher growth in countries with less developed financial systems. In addition, Greenidge et al. (2012) studies the thresholds effects between public debt and economic growth in the Caribbean, finding that there is a threshold level of public debt (55 to 56 percent) after which additional public debt has contractionary effects on economic activity.

[201] Recall that an indicator function takes the value of 1 if the function is true and zero otherwise.

The sequential estimation procedure for Eq. (4.6) follows the statistical theory and threshold estimation methods developed by Hansen (1996, 1999, 2000). An initial step removes the countries specific effects (η_i) by subtracting the individual-specific means. Following Chan (1993) and Hansen (2000), the threshold estimate ($\hat{\tau}$) is obtained by least squares minimization: $\hat{\tau} = argmin_{\tau}S(\tau)$; where $S(\tau)$ denotes the sum of squared errors. In that order, $S(\tau)$ is obtained by the ordinary least squares estimation of the slope coefficients (β_1 and β_2). The least squares minimization procedure starts sequentially by sorting the observations based on the threshold variable ($\Pi_{i,t}$) and searching for the threshold value (τ) that minimizes the sum of squared errors.

The search for the threshold should be restricted such that a minimum amount of observations (i.e., 1% or 5%) lies within each regime in order to prevent the case that a threshold estimate is selected from few observations. For each of the distinct threshold values—during the search process—the sum of squared errors is calculated, and the slope coefficients are estimated. The threshold estimate ($\hat{\tau}$) is then selected as the value that produces the minimum sum of squared errors (Hansen, 1999).

To determine the statistical significance of the threshold or to test for the null hypothesis of no threshold effects ($\beta_1 = \beta_2$) amounts to testing whether the threshold estimate ($\hat{\tau}$) is consistent. Chan (1993) and Hansen (2000) have shown that when the threshold estimate ($\hat{\tau}$) converges to its true value (τ) the threshold effect ($\beta_1 \neq \beta_2$) is statistically significant. In that order, a likelihood ratio statistic ($LR(\tau)$) can be used to test the null hypothesis (H_0: $\hat{\tau} = \tau$). The null hypothesis is rejected if $LR(\tau)$ exceeds the critical values. The confidence interval for the threshold estimate is obtained by inverting the likelihood ratio statistic. Hansen (1999) suggest to draw a figure where $LR(\tau)$ is plotted against the threshold parameter (τ), while a flat line is draw at the critical value. In that order, the confidence interval for the threshold is constructed from the values for which $LR(\tau)$ exceeds the critical value, and the threshold estimate ($\hat{\tau}$) is the value that minimizes the $LR(\tau)$ series.

While Hansen (1999) develops threshold estimation, testing and inference methods for non-dynamic panels with individual specific effects, these methods are non-robust to the inclusion of a lagged dependent variable and to the consideration of potential heteroskedasticity of unknown form in the residual term ($e_{i,t}$). These restrictions limit the empirical application of Hansen's panel threshold models, therefore the adaptation of the heteroskedasticity-robust Hansen (1996, 2000) methods to panel data[202].

By construction, the threshold models described by Eq. (4.5) and Eq. (4.6) are a discontinued threshold models. The statistical theory for threshold estimation, testing and inference of discontinued threshold models is developed by Hansen (1996, 1999, 2000) and we follow closely their methods. The intuition for the implementation of discontinued threshold models builds on that of Drukker et al. (2005) who suggests this specification is more appropriate when marginal variations of inflation around the threshold may have different effects on economic growth.

A key limitation of Hansen (1996, 1999, 2000) methods is that these do not extend to the inclusion of endogenous regressors[203]. In that order, while the threshold variable is conventionally assumed exogenous in this class of models, the explanatory regressors are considered strictly exogenous thereby excluding the interesting case of dynamic panel data models. The dynamic panel cross-country growth model characterized by Eq. (4.1) calls for the inclusion of initial income as a lagged dependent variable within the threshold models of Eq. (4.5) and Eq. (4.6) thereby leading to a dynamic threshold model with initial income as a lagged dependent variable and endogenous regressor, for which appropriate threshold estimation and inference methods needs to be derived.

4.3.5 Dynamic panel threshold model

The development of threshold models with endogenous regressors crucially assumes that while the threshold variable has a continuous distribution and

---

[202] The empirical application of Hansen (1999) methods to non-dynamic panel threshold models under the condition of heteroskedastic errors may infringe some of the distributional theory assumptions of their estimator as these do not extend to the case of heteroskedastic residuals. Nevertheless, Hansen (1999) suggests that the panel data estimation of threshold models such as the one characterized by Eq. (4.6) can be carried out using similar methods to the ones proposed by Hansen (1996, 2000) which use heteroskedasticity robust procedures.

[203] Another empirical limitation is that these methods appear sensitive to missing values in the data. In addition, the panel threshold estimation requires the data to proceed from a balanced panel. These methods also assume the threshold variable and the control regressors to be time varying for the purpose of identification, in other words, these variables should not be time invariant.

is strictly exogenous, some of the explanatory regressors can be considered as endogenous. In that order, Caner and Hansen (2004) builds on Chan (1993) and Hansen (1996, 1999, 2000) to develop a statistical theory of inference, estimation and testing procedures for the instrumental variable estimation of threshold models with endogenous regressors in a cross-sectional setting.

For growth econometrics, a key empirical limitation of Caner and Hansen (2004) is that their methods does not allow the inclusion of a lagged dependent variable, nor are applicable to observations in a panel data setting. Improving on these limitations, Kremer et al. (2013) extends the Hansen (1999) and Caner and Hansen (2004) threshold estimation procedures to dynamic panel threshold model with endogenous regressors[204]. For these reasons, in this chapter we follow the statistical theory for threshold regressions of dynamic panel threshold models proposed by Kremer et al. (2013)[205].

To study threshold effects in the relationship between inflation and economic growth in a panel of 32 Latin American economies over the period from 1960 to 2010, we estimate the following dynamic panel threshold model:

$$dlny_{i,t} = \beta_1' \Pi_{i,t} I(\Pi_{i,t} \leq \tau) + \delta_1 I(\Pi_{i,t} \leq \tau) + \beta_2' \Pi_{i,t} I(\Pi_{i,t} > \tau) + \theta' \Omega_{i,t} + \eta_i + \upsilon_{i,t} \tag{4.7}$$

where $dlny_{i,t}$ denotes the growth rate of real GDP per capita; $I(\cdot)$ is an indicator function where $\Pi_{i,t}$ denotes the inflation function and threshold variable; the threshold parameter (τ) is unknown and is estimated by the

[204] A key feature of Kremer et al. (2013) dynamic panel threshold estimation methodology is that their methods allows the inclusion of a lagged dependent variable, endogenous regressors and individual specific effects.

[205] Dynamic panel threshold models offer many advantages. First, by using panel data threshold regressions we exploit the cross-sectional and time series variation in the data, thereby yielding more accurate and precise estimates for the inflation threshold. Second, we account for the endogeneity bias in the estimates caused by the inclusion of initial income as an explanatory variable in the model. By construction, initial income is an endogenous regressor, and therefore accounting for its endogeneity is important in the estimations. Third, the model also allow us to include initial income as a lagged dependent variable without infringing the Hansen (1999, 2000) and Caner and Hansen (2004) statistical theory for threshold regressions.

model; δ_1 denotes differences in the regime intercepts (Bick, 2010)[206]; $\Omega_{i,t}$ is a m vector of control regressors that includes $x_{i,t}$ exogenous variables and $z_{i,t}$ endogenous variables[207]; η_i denotes the country specific effect; $\upsilon_{i,t}$ is the country specific error term[208]. The β's coefficients are regime dependent and measures the marginal growth effects of inflation below and above the inflation threshold (τ). The row vector of coefficients for the control regressors (θ) is regime independent and measures the growth effects of the explanatory variables. The subscripts i and t indexes respectively the number of countries and the time periods.

The estimation methodology for the dynamic panel threshold model follows closely that of Kremer et al. (2013). In an initial step, the country specific effects are removed by applying Arellano and Bover (1995) forward orthogonal deviation transformations such that serial correlation in the residual term is avoided[209]. After country specific effects are eliminated, then Caner and Hansen (2004) instrumental variable estimation methods for a threshold can be implemented. In that order, a reduced form regression is estimated where the endogenous variable is explained by the instruments. In what follows, fitted values of the endogenous variable are obtained from the regression and then substituted into the baseline threshold equation, where the threshold estimate is then obtained by least squares minimization. The

[206] We control for differences in regime intercepts that are common across countries. The inclusion of regime specific intercepts allow us to control for one form of omitted variables bias. Should the data evidence some form of regime specific intercepts, then omitting these from the estimated equation may cause biased estimates (Bick, 2010). The potential bias can be interpreted as amounting to the estimated coefficient δ_1.

[207] The vector of control regressors ($\Omega_{i,t}$) is standard and includes the initial level of income, the investment share to GDP, the population growth rate, the terms of trade growth and volatility, and the trade openness growth and volatility (Khan and Senhadji, 2001, Burdekin et al., 2004, Drukker et al., 2005, Kremer et al., 2013). In addition, initial income is specified as the endogenous variable, where all the other control regressors are assumed strictly exogenous.

[208] We assume $\upsilon_{i,t}$ is independent and identically distributed (iid) with $N(0, \sigma^2)$.

[209] This transformation removes the individual's specific effects by subtracting contemporaneous observations from the average of future observations. Given the presence of a lagged dependent variable in the model, eliminating countries specific effects via the first differences or the within-groups transformation may induce serial correlation in the residual term thereby infringing Hansen (1999, 2000) and Caner and Hansen (2004) statistical theory for threshold estimation.

threshold estimate ($\hat{\tau}$) is the value that minimizes the sum of squared errors of the model.

In what follows the sample is split based on the estimated threshold, and in the final step, the estimates for the slope coefficients are obtained by generalized method of moments estimations given the threshold estimate and the selected instruments[210]. Confidence intervals for the threshold estimate ($\hat{\tau}$) are obtained by the inversion of the modified likelihood ratio statistic. The likelihood ratio statistic is modified to account for the number of time periods used in each cross section. In that order, the asymptotic 95% confidence region for the threshold estimate at the 5% critical value (c) is given by: $\hat{\Gamma}^* = \{\tau : LR_n(\tau) \leq c\}$ (Caner and Hansen, 2004, Kremer et al., 2013).

The Kremer et al. (2013) class of threshold models is of more interest to our estimation of inflation thresholds due to the importance of including initial income in the growth model in order to avoid unnecessary bias in the estimates. In addition, we find evidence which favours the inclusion of individual countries specific effects to control for potential unobserved heterogeneity in the threshold regressions[211].

A key difference between these estimators is that the estimation of a threshold in panel data models with individual specific effects and a lagged dependent variable pose additional difficulties to the estimation procedure. In this case, the Hansen (1999) and Caner and Hansen (2004) distributional theory is invalid due to the negative serial correlation induced in the error term by the fixed effects elimination in the presence of a lagged dependent variable such as initial income. Kremer et al. (2013) builds on these estimators by applying the Arellano and Bover (1995) forward orthogonal deviation transformation to eliminate the fixed effects and therefore maintain the orthogonality condition of the residuals such that Caner and Hansen (2004) instrumental variable estimation methods for a threshold could be applied to panel data models with individual specific effects, a lagged dependent variable and endogenous regressors.

Finally, to maintain the comparability of our results with previous studies, our methodologies includes the estimation of inflation threshold using both

[210] Following Arellano and Bover (1995) and Kremer et al. (2013) we use lagged levels of initial income as instruments.

[211] These specification tests are available from the author upon request.

cross-sectional and panel data while assuming in different scenarios the exogeneity of all the variables, and the potential endogeneity of initial income and inflation. In addition, we use different threshold estimation techniques in both static and dynamic cross-sectional and panel data settings.

4.3.6 Data

A data set is compiled for the thirty-two countries classified in Latin American economies according to the International Monetary Fund (IMF) classification[212]. The time span of the data ranges from 1960 to 2010. We use a balance and an unbalanced panel where the variables series are five-year averages across the sample period[213]. Alternatively, we also use a cross-sectional sample where the variables series are defined as averages from 1970 to 2010[214].

One of the main sources of data is the Penn World Tables (PWT)[215]. In that order, economic growth is defined as the growth rate of the PPP converted real GDP per capita in constant U.S. Dollars of 2005 (rgdpch)[216]. Initial income is measured by the initial level of the real GDP per capita at the beginning of each five-year interval (Durlauf et al., 2005). The level of investment in the economy is defined as the gross capital formation as a percentage of the gross domestic product (GDP). In that order, real investment is measured by the investment share of the PPP converted GDP per capita in constant U.S. Dollars of 2005 (ki). The inclusion of the investment share to GDP in the model allows us to control for the potential effects of inflation through the investment channel (Khan and Senhadji, 2001, Espinoza et al., 2010).

Following Durlauf et al. (2005), we control for employment effects in the growth model and hence includes a measure for the growth rate of the total population in thousands (pop). To control for the potential effects of inflation through the trade channel we include a measure for real trade openness at

[212] See Appendix A.1 for the list of countries.

[213] The choice of a five-year average time window follows standard conventions in the literature (Durlauf et al., 2005)

[214] The choice for the time span of the cross-sectional sample is databased as data for the economic growth rates of the Latin American economies has a wider coverage since the 1970's.

[215] In particular, we use the Penn World Tables version 7.1.

[216] Growth rates are calculated by logarithmic differences.

2005 constant prices (openk). Trade openness is defined as the total share of exports as a proportion of imports. In addition, we also include the five-year standard deviation of the real trade openness as a measure for trade openness volatility (Kremer et al., 2013).

Inflation is defined as the percentage change of the national end of period consumer prices index[217]. The data for inflation proceeds from the IMF's International Financial Statistics (IFS line 64)[218]. Following Drukker et al. (2005) and Kremer et al. (2013), we use a semi-log transformation of the inflation rate as defined in Eq. (4.1) in order to incorporate negative inflation rates and high inflation observations. Latin America has suffered from severe macroeconomic crisis since the late 1970's among which stand out banking, inflation and currency crisis[219]. Following Laeven and Valencia (2010, 2012) and Reinhart and Rogoff (2009), we account for macroeconomic crisis in the region by defining a measure of banking and currency crisis which is the number of years in crisis as a proportion of the total number of years within each five-year interval (ratio from 0 to 1).

To account for the effects of supply shocks in the estimation of the inflation thresholds, in addition to changes in the patterns of international trade due to real exchange rate variations, we include two measures of changes in the terms of trade (Fischer, 1993, Burdekin et al., 2004, Bick, 2010, Espinoza et al., 2010). The terms of trade are measured by the exports as capacity to import in local currency units and the data proceeds from the World Bank's World Development Indicators (WDI)[220]. The terms of trade growth rate is measured by the growth rate of the exports as capacity to imports while the terms of trade volatility is defined as the five-year standard deviation of the terms of trade growth rates.

Following Rousseau and Wachtel (2002), we control for the role of financial development on inflation performance, and therefore use as proxy a measure of domestic credit to the private sector as a proportion of GDP (fs.ast.prvt.gd.zs). In addition, we also control for the rate of growth of the

---

[217] The base year for the index is 2005.

[218] Inflation data for Antigua and Barbuda and Guyana proceeds from the IMF's World Economic Outlook (WEO) database.

[219] See Edwards (1995), Robinson (2004) and Franko (2007) for a survey on crisis and their impact on output growth in the Latin American economies.

[220] The terms of trade series is the exports as capacity to imports (ny.exp.capm.kn).

broad money supply as a main determinant of inflation (Cagan, 1956, Friedman and Allen, 1970, Rousseau and Wachtel, 2002)[221]. To control for the role of fiscal policy on inflation threshold and to whether the fiscal stance may drive inflation and economic performance we follow Fischer (1993) and Easterly and Rebelo (1993) and include a measure of the government cash/surplus deficit to GDP obtained from the International Financial Statistics, and a measure for the government consumption expenditures as a percentage of GDP[222]. The data for these variables proceeds from the World Development Indicators (WDI).

Table 4.1 provides the descriptive statistics of the dataset. An initial observation is that economic growth is relatively modest in the region while inflation is normally double digits. This result is not surprising, Furtado (1965) suggested in the late 1960's that there is a tendency towards general increases in the price levels and a deceleration of per capita growth rates in Latin America. Nevertheless, the region has become relatively richer since the 1970's compared to other world regions.

According to the World Bank Atlas method for the gross national income (GNI) per capita classification, most Latin American countries can be classified as upper-middle-income economies with an average GNI per capita of approximately US$7,462 as of 2010. The richest economy in the region is The Bahamas and the poorest is Haiti.

The country with the highest average growth rate in the region is Grenada (4%) which has experienced an average inflation of 3.9% during the sample period. As the evidence in the data suggests, Latin America offer many examples of moderate growth with low, moderate and high levels of inflation[223]. In that order, inflation and economic growth performance in the region is a complex issue worth of further research (Baer, 1967).

---

[221] We use the World Bank broad money supply as a percentage of GDP (fm.lbl.bmny.gd.zs).

[222] To obtain the government cash surplus/deficit to GDP we use data from IFS line cCSD.BA scaled by GDP (line 99). Data for the government final consumption expenditures is obtained from the WDI (ne.con.govt.zs).

[223] Economic growth in Brazil, for example, has averaged 2.4% while inflation has averaged 68% when taking into account the hyperinflation crisis of the 1980's and 1990's.

Table 4.1
Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum	Observations
Real GDP per capita growth (%)	1.83	2.85	-7.82	9.87	280
Inflation function (%)	9.06	3.94	0.33	2,692.45	272
Initial income (US$ at 2005 constant prices)	5,416.11	1.92	1,269.05	32,374.29	290
Investment share (% of GDP)	20.97	1.46	3.87	73.52	290
Population growth (%)	1.61	1.06	-1.25	4.31	300
Terms of trade growth (%)	4.83	5.62	-11.46	21.09	167
Terms of trade volatility	12.23	7.65	1.58	49.40	172
Trade openness (% of GDP)	58.33	1.99	9.35	193.02	290
Trade openness volatility	0.08	0.08	0.00	1.13	280
Domestic credit to private sector (% of GDP)	28.22	1.79	2.75	103.50	271
Banking and currency crisis (ratio from 0 to 1)	0.17	0.31	0.00	1.00	300
Money supply growth (%)	0.02	0.06	-0.26	0.22	269
Government cash surplus/deficit (% to GDP)	0.98	1.03	0.76	1.04	157
Government consumption (% to GDP)	12.84	1.43	4.10	34.02	256

Notes: The sample is an unbalanced panel of thirty Latin American economies from 1960 to 2010. Nicaragua and Trinidad and Tobago are excluded from the sample due to extreme values. The unit of observations is in five-year averages.

Table 4.2
Average growth per inflation group in Latin America, 1960-2010

Inflation				Economic growth	
Group	Lower bound	Upper bound	Mean	Mean	Observations
A	-0.10	1.98	1.29	2.48	30
B	2.07	3.14	2.62	2.83	30
C	3.20	5.06	4.14	1.73	30
D	5.13	6.91	6.02	2.54	30
E	6.91	9.28	8.08	1.62	30
F	9.37	13.26	11.43	2.05	30
G	13.45	19.42	16.48	2.07	30
H	19.44	38.85	25.19	0.52	30
I	39.69	2692.45	341.82	0.02	32

Notes: Inflation is defined as the percentage growth rate of the consumer price index at the end of the period. Economic growth is defined as the percentage growth rate of the PPP converted GDP per capita (chain series) at 2005 US$ dollars constant prices. Values are in five years averages. Inflation groups are organized by increasing inflation rates. The lower bound and upper bound correspond to the lowest and highest inflation observation within each group. In that order, the lowest inflation observation in the sample correspond to Argentina (1996-2000), and the highest correspond to Bolivia (1981-1985). The mean inflation and growth is the simple average across countries over each inflation group. The total number of observations is 272.

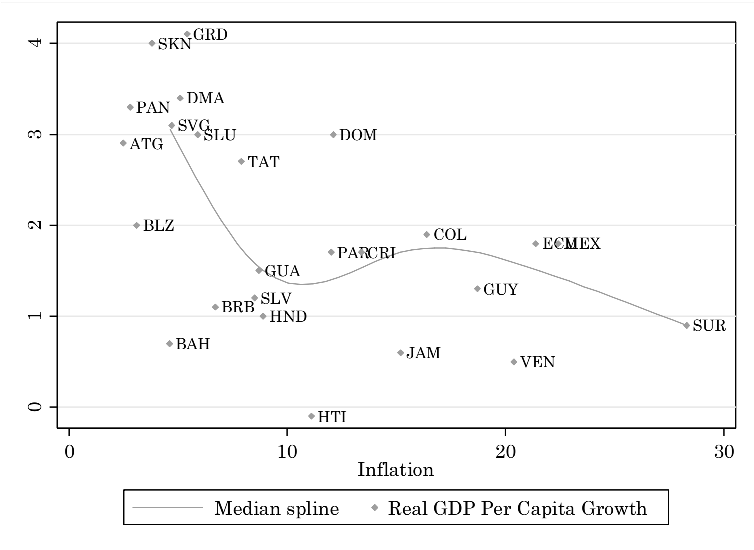

Fig. 4.1. Economic growth and inflation performance in Latin America, 1960-2010. *Notes:* The sample includes twenty-five Latin American economies[224]. Values are long run averages from 1960 to 2010. A cubic linear spline is fitted with cross medians as knots. Economic growth is defined as the percentage growth rate by logarithmic differences of the PPP converted GDP per capita (chain series) at 2005 constant prices. Inflation is defined as the percentage growth rate of the end of period consumer price index.

Table 4.2 presents a breakdown on economic growth performance per inflation group in Latin America. The data evidence a clear negative relationship between inflation and economic growth, however the growth effects of inflation varies per inflation group thus showing evidence of nonlinearities. For instance, while the inflation group B register an average growth of 2.83%, inflation group C has an average growth of 1.73%, and the inflation group D has a higher growth of 2.54%. This evidence supports the view of unequal growth effects of inflation across different inflation rates.

Figure 4.1 documents the relationship between inflation and economic growth in Latin America. The evidence also suggests a negative and nonlinear relationship between inflation and economic growth in the region.

---

[224] The figure excludes countries which experienced inflation rates exceeding 40% during the sample period as these may characterize prolonged periods of inflation crisis (Cagan, 1956, Bruno and Easterly, 1998). The excluded countries are Argentina, Bolivia, Brazil, Chile, Nicaragua, Peru and Uruguay.

Our evidence favours the nonlinearity hypothesis in the inflation growth nexus as initially proposed by Fischer (1993) and De Gregorio (1992a). A cubic spline function is also fitted from the data, and shows that the relationship between inflation and growth is nonlinear at a knot or threshold close to a 15% inflation rate. Economic growth appears to correlate positively from low to moderate inflation rates while high inflation has a clear detrimental growth effects on economic activity[225].

4.4 Inflation thresholds in Latin America

An important branch of the existing literature has been devoted to explore the role of inflation threshold on economic growth[226]. The existing literature largely focuses on the point estimates and confidence intervals constructions of inflation thresholds in the advanced and developing economies. Conventionally, a panel threshold model is estimated to determine the threshold effects of inflation given a standard set of control regressors. Much of the criticism to this literature, however, is oriented towards the role of country specific inflation thresholds, the potential endogeneity of the initial income and the inflation regressor within the model, and the potential role of alternative explanatory variables that could drive inflation performance and economic growth possibly determining the observed nonlinearities and threshold effects.

In this section, we contribute to the existing literature on inflation thresholds by examining the relationship between inflation thresholds and economic growth in the Latin American economies. To the best of our knowledge, this is the first study to explore inflation thresholds specifically in the Latin American region. Unlike previous studies, we use an up-to-date dataset for the region and estimate alternative threshold models under a standard set of control regressors and other relevant explanatory variables.

---

[225] Table B.3 (Appendix B) presents further evidence on the pairwise correlation coefficients between inflation and growth, also suggesting a negative and statistically significant correlation among these variables.

[226] See, for example, the works of Fischer (1993), Sarel (1996), Khan and Senhadji (2001), Burdekin et al. (2004), Drukker et al. (2005), Bick (2010) and Kremer et al. (2013).

In what follows, we present evidence on the inflation-growth nexus in the Latin America economies, the role of nonlinearities and threshold effects in this relationship, the estimation of the growth effects of inflation, and the estimation of the point estimates and confidence intervals for the inflation threshold. We also examine the role of financial development and macroeconomic crisis in the threshold estimations. In addition, we present an innovative approach on the role of fiscal policy in the determination of inflation thresholds in Latin America.

4.4.1 Existence of an inflation-growth nexus

An initial approach in the determination of inflation thresholds is the establishment of a significant relationship between inflation and economic growth. If inflation is not correlated at all with economic growth then inflation thresholds may have no role on economic activity. For this aim, a first step is to verify the existence of an inflation-growth nexus.

Consider the growth model characterized by Eq. (4.1) estimated through the pooled ordinary least squares estimator, the within-groups estimator and the two-stage least-squares fixed effects estimator. Results from the estimation of this model may give evidence on whether the growth effects of inflation—represented by the β coefficient of the inflation function—may be different than zero at conventional levels of statistical significance.

Table 4.3 presents the result on the existence of an inflation-growth nexus in Latin America. Our primary concern is on whether inflation is at all correlated or not with economic growth, and on whether the growth effects of inflation are statistically significant. The estimates for the inflation function coefficient show a negative and significant correlation between inflation and economic activity. A 1% increase in inflation may reduce output growth by more than 1/3 percentage points. In that order, inflation has clear detrimental effects on output growth in Latin America.

Table 4.3
The inflation-growth nexus in Latin America

Dep. var.: real GDP per capita growth Period: 1960-2010	(1)	(2)	(3)
Inflation function	-0.452***	-0.370**	-0.350**
	(0.100)	(0.136)	(0.146)
Initial income	-0.924**	-3.875***	-2.600*
	(0.326)	(1.083)	(1.426)
Investment share	1.775***	2.592***	2.773***
	(0.474)	(0.760)	(0.858)
Population growth	-0.774***	-0.607**	-0.767**
	(0.186)	(0.255)	(0.344)
Terms of trade growth	0.182***	0.167***	0.179***
	(0.0409)	(0.0395)	(0.0437)
Terms of trade volatility	-0.0414**	-0.0321	-0.0459
	(0.0180)	(0.0275)	(0.0323)
Trade openness	0.0844	0.125	-0.0926
	(0.356)	(0.853)	(0.696)
Trade openness volatility	-0.146	-1.592	-0.108
	(3.174)	(4.208)	(4.491)
Constant	5.637*	26.53***	
	(2.842)	(7.754)	
Time effects	Yes	Yes	Yes
Country specific effects	No	Yes	Yes
Adjusted R-squared	0.56	0.62	0.67
F-statistic *(p-value)*	0.00	0.00	0.00
Instrumental variables specification tests:			
Kleibergen-Paap *rk* LM test for underidentification			0.00
Kleibergen-Paap *rk* Wald F statistic for weak identification			102.73
Endogeneity test			0.21
Observations	163	163	151
Number of countries		21	20

Notes: This table reports estimates of Eq. (4.1) through the pooled ordinary least squares estimator (1), the within-groups estimator (2), and the two-stage least squares fixed effects estimator (3). The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The unit of observations is in five-year averages. The initial income is considered as the endogenous regressor in the instrumental variables estimations. Lagged levels of initial income up to the first lag are used as instruments. The instrumental variables specification tests are those of Kleibergen and Paap (2006), Stock and Yogo (2005) and Baum et al. (2003, 2007). These tests report the p-values, except for the Kleibergen-Paap *rk* Wald F statistic whose critical value according to Stock and Yogo (2005) approximate 16.38 for the 10% maximal IV size. The Hansen (1982) *J* test of overidentifying restrictions is not reported as the equation is exactly identified. Statistics are heteroskedasticity and autocorrelation consistent (HAC). Clustered-robust standard errors are reported in the pooled ordinary least squares and the within-groups estimations. The two-stage least squares estimates report robust standard errors obtained through the Barlett kernel with Newey-West (1994) fixed bandwidth rule. Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

We apply different econometric methods to obtain these estimates. First we estimate Eq. (4.1) by assuming a pooled ordinary least-squares specification while controlling for time specific effects and a standard set of standard control regressors. Since our findings may be sensible to potential unobserved heterogeneity due to different cultural, political and socio-economic factors in the Latin American economies, we carried out fixed effects estimations with time and country specific effects[227]. Finally, we control for the potential endogeneity of initial income by using instrumental variables estimations[228]. Our main hypothesis of a significant inflation-growth nexus in the Latin America economies is maintained in accordance with the historical evidence for the region[229].

These findings reflect a negative correlation between inflation and economic growth in Latin America. A more proper question is whether we can assume this relationship as potentially causal. For this aim, we conducted a pairwise Granger (1969) causality test for panel data and at conventional levels of statistical significance rejected both null hypotheses that inflation does not Granger cause economic growth, and that growth does not Granger cause inflation[230]. However, it is important to note that the statistical significance of the hypothesis that growth does not cause inflation is relatively weaker than the hypothesis that inflation does not cause growth.

---

[227] Across all the estimations time and countries specific effects are found to be significant in explaining the relationship between inflation and economic growth in Latin America.

[228] By construction, initial income is an endogenous regressor since growth rates are calculated by logarithmic differences. In that order, initial income is a right hand side lagged dependent variable. We use lagged levels of initial income as instruments for the two-stage least squares estimations (Barro and Sala-i-Martin, 2004). Following the Kleibergen and Paap (2006) LM test and the Wald F statistic, we reject the null hypothesis of underidentification and weak instrumentation in our estimates.

[229] The estimates maintain their significance levels and absolute values. In addition, we controlled for potential cross-sectional dependence by implementing fixed effects estimations with Driscoll-Kay standard errors (Driscoll and Kraay, 1998). We do not find any significant evidence in favour of cross-sectional dependence in our estimates. These results are not presented here for the ease of exposition but are available from the author upon request.

[230] See Table B.4 (Appendix B) for a description of the Granger causality test. Note that Granger causality does not imply a causal relationship in the strict sense of the word. The test can more generally be viewed as a test on whether lagged inflation may significantly explain current growth rates, and on whether past growth rates may explain current inflation.

As in Fischer (1993) and Ghosh and Phillips (1998) our evidence supports the view that the potential causality runs primarily from inflation to output growth rather than the other way around, and that the potential endogeneity bias caused by the inflation regressor may be relatively small.

To formally address the possible simultaneity bias caused by the inflation function regressor we estimate Eq. (4.1) via the two-stage least squares estimator where inflation is treated as an endogenous regressor (Ghosh and Phillips, 1998, Schaffer, 2012). To control for the potential endogeneity of inflation we use past inflation rates as instruments (Arellano and Bover, 1995)[231]. In that order, we conducted a series of instrumental variables endogeneity tests proposed by Baum et al. (2003, 2007). Our results show that inflation can actually be treated as an exogenous regressor in the model[232]. In line with these findings, Fischer (1993), Sarel (1996) and Ghosh and Phillips (1998) also found evidence that causation primarily run from inflation to economic activity in which case the possible simultaneity bias caused by the inflation regressor is relatively small. Our findings suggests that for the case of the Latin American economies the causality mainly runs from inflation to economic activity as in our view inflation is also determined by structural rigidities and socio-economic factors in these economies as the ones described by Baer (1967) and Fischer and Mayer (1980).

4.4.2 Nonlinearities in the relationship between inflation and economic growth

The classical tradition normally assumes no long run effects of inflation on economic activity (McCallum, 1990). However, an important branch of the existing literature shows substantial evidence in favour of output-inflation trade-offs, and the existence of a nonlinear relationship between inflation and economic growth, as the growth effects of inflation may vary across different inflation rates (Driffill et al., 1990, Fischer, 1993, Sarel, 1996, Burdekin et al.,

---

[231] Due to data availability the choice of other instruments suggested by Ghosh and Phillips (1998) such as the measures of central bank independence and governors turnover are not available for most countries in Latin America. Our specification test suggests that lagged levels of inflation are better instruments to predict current inflation, perhaps due to inflation inertia in Latin America (Kiguel and Liviatan, 1988, Cardoso and Fishlow, 1992).

[232] These results are also available from the author upon request.

2004). At lower levels of inflation, economic growth appears to be less affected by additional inflation than at higher inflation levels. In other words, the marginal costs of inflation may increase at higher inflation rates.

The concept of thresholds effects is closely linked to that of nonlinearities in the inflation-growth nexus. Our hypothesis is that there is a certain threshold level of inflation below which additional inflation correlate (sometimes insignificantly) with higher economic growth. However, once inflation has exceeded the threshold, then the growth effects of inflation turn up negative and statistically significant. In other words, as the marginal costs of inflation rise with higher inflation observations, these costs turn up significantly higher as the inflation threshold is exceeded.

Figure 4.1 presented preliminary evidence in favour of a nonlinear relationship between inflation and economic growth in Latin America. Our data suggests that average growth declines faster after inflation has turned up double digits. Following the approaches outlined by Bruno and Easterly (1998) and Burdekin et al. (2004), we estimated Eq. (4.1) via the pooled least squares and the within-groups estimator by adding progressively higher inflation observations and controlling for high inflation episodes[233]. Our results are presented in Table 4.4, and show an overall negative impact of inflation on economic activity. However, the growth effects of inflation are non-significant once we control for unobserved heterogeneity using the within-groups estimation. In addition, the marginal costs of inflation are relatively lower when we considered inflation rates up to 40%.

[233] Bruno and Easterly (1998) suggests that the correlation between inflation and economic growth is due to the inclusion of high inflation observations, in their view those that exceed 40%. In addition, Cagan (1956) define hyperinflation episodes as those that exceed 50%. Therefore, to control for periods of high and extreme inflation episodes our estimations considered inflation rates observations less than 40%.

Table 4.4

Thresholds effects and nonlinearities in the inflation-growth nexus in Latin America

Dep. var.: real GDP per capita growth Period: 1960-2010	(1)	(2)	(3)	(4)
Inflation function	-0.414*	-0.283		
	(0.201)	(0.292)		
Marginal growth effects of inflation				
Inflation $(\hat{\beta}_1)$: below 14%:			-0.177	0.00707
			(0.218)	(0.260)
Inflation $(\hat{\beta}_2)$: above 14%:			-1.651*	-1.973*
			(0.845)	(0.983)
Initial income	-0.803**	-2.839**	-0.733*	-2.487*
	(0.379)	(1.222)	(0.387)	(1.204)
Investment share	1.802***	2.210**	1.783***	2.048**
	(0.503)	(0.813)	(0.510)	(0.870)
Population growth	-0.788***	-0.495*	-0.819***	-0.644***
	(0.202)	(0.257)	(0.199)	(0.219)
Terms of trade growth	0.184***	0.175***	0.188***	0.182***
	(0.0332)	(0.0299)	(0.0319)	(0.0292)
Terms of trade volatility	-0.0325**	-0.0148	-0.0243	-0.00742
	(0.0139)	(0.0235)	(0.0148)	(0.0246)
Trade openness	0.0797	-0.0465	0.0713	-0.303
	(0.397)	(0.822)	(0.408)	(0.749)
Trade openness volatility	-1.831	-3.498	-2.774	-4.791
	(3.707)	(4.282)	(3.772)	(4.408)
Constant	4.531	19.09*	3.949	17.87*
	(3.107)	(9.452)	(3.135)	(8.990)
Time effects	Yes	Yes	Yes	Yes
Country specific effects	No	Yes	No	Yes
Adjusted R-squared	0.51	0.57	0.52	0.59
F-statistic *(p-value)*	0.00	0.00	0.00	0.00
Observations	135	135	135	135
Number of countries		21		21

Notes: Estimates (1) and (2) are obtained via the estimation of Eq. (4.1) through the pooled ordinary least squares estimator and the within groups estimator respectively. Estimates (3) and (4) are obtained via the estimation of Eq. (4.2) through the pooled ordinary least squares estimator and the within groups estimator. The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The unit of observations is in five-year averages. The threshold variable is the inflation function. The estimations only consider inflation rate observations less than 40% for each country. The overall growth effect of inflation is given by the inflation function coefficient in the standard growth regresssion (1) and (2). In the spline function regressions (3) and (4), the overall growth effect of inflation is given by the β_1 coefficient when inflation is below the threshold (14%), however, when inflation exceeds the specified threshold, the overall growth effect of inflation is given by the sum of the β's coefficient. Statistics are heteroskedasticity and autocorrelation consistent (HAC). Clustered-robust standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

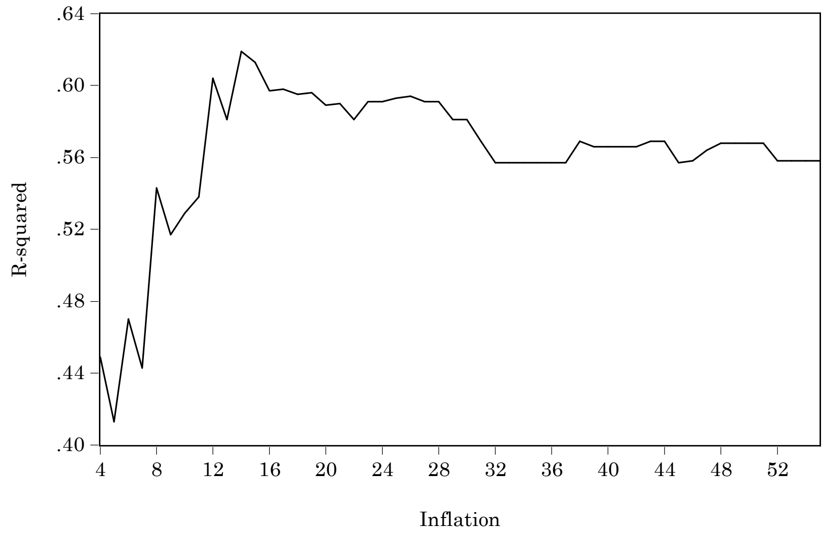

Fig. 4.2. Estimates of Eq. (4.2) across different inflation rates. Notes: Within-group estimations with time and country specific effects. The sample is an unbalanced panel of twenty-one Latin American economies from 1960 to 2010. The adjusted R-squared reaches a global maximum when inflation approximates 14%.

Our findings initially supports Bruno and Easterly (1998) view that inflation may be uncorrelated with economic growth at low and moderate inflation levels. However, it is possible that these results may be driven by unspecified nonlinearities and threshold effects in the inflation-growth nexus. Thus accounting for nonlinearities and threshold effects in the inflation-growth relationship may help to clarify our results with respect to the real growth effects of inflation at low and moderate inflation rates. To investigate further this hypothesis, we follow Burdekin et al. (2004) approach and estimate a single knot spline function model (Eq. 4.2) across varying inflation rates[234]. Following the search procedure outlined in section 4.3, we choose as knot or point of structural break the inflation rate at which the sum of squared residuals of the model are minimized or equivalently the point at which the adjusted R-squared of the model is maximized (Sarel, 1996).

The results from estimating Eq. (4.2) across varying inflation rates are presented in Figure 4.2. Given the figure, we can observe that the R-squared

[234] See Greene (2012) for a discussion on spline function estimations.

of the model reaches a global maximum when the inflation rate approximates 14%. This evidence may indicate a possible structural break in the relationship between inflation and economic growth at a knot of 14%.

Table 4.4 also report the results from the spline function (Eq. 4.2) estimates at a 14% inflation rate. Our aim is to determine the statistical significance of the threshold or knot at a 14% inflation rate. In addition, we seek to determine the growth effects of inflation ex-ante and ex-post the proposed inflation threshold. First, the results from the regressions (3) and (4) in Table 4.4 show that the sum of the inflation coefficients is actually nonzero[235]. Overall, we find that the growth effects of inflation are negative and significant at conventional levels of statistical significance.

Second, once we have accounted for potential unobserved heterogeneity through the fixed effects estimation, the growth effects of inflation ex-ante and ex-post the threshold are significantly different. Our findings suggest that inflation rates below the threshold of 14% are positive but statistically insignificant. However, inflation rates that exceed the threshold at 14% have a negative and significant effect on economic activity[236].

The evidence of significant structural breaks in the relationship between inflation and economic growth in the Latin America economies provides further support for the hypothesis of non-equal growth effects of inflation across different inflation rates. Overall, by examining the absolute values of the coefficients in Table 4.4 these results suggests that the growth effects of inflation are underestimated when no thresholds effects and nonlinearities are considered in the estimation[237].

As robustness to our findings, Table B.5 (see Appendix B) reports the cross-sectional estimates of Eq. (4.1) and Eq. (4.2) following the methodology outlined previously. Our findings show no cross-sectional evidence in favour

---

[235] We refer to an F-test on whether the sum of the inflation function coefficient plus the coefficient for the knot at 14% is statistically different than zero.

[236] Accounting for the endogeneity of initial income does not change our main results. In a two-stage least squares estimation of Eq. (4.2) using first lags of initial income as instrument, we find an identical result where inflation is statistically significant and negatively correlated with economic growth once inflation rates exceed the inflation threshold.

[237] Note that in the spline function estimation the total growth effects of inflation are the sum of the inflation function coefficient plus the coefficient for the knot at 14%.

of inflation-growth trade-offs even after accounting for inflation thresholds in a spline function model[238]. These results are not surprising. Bruno and Easterly (1998) ascribe to an empirical paradox the lack of cross-sectional evidence in favour of inflation and economic growth trade-offs while using average of the series of 30 years or more. Levine and Renelt (1992) and Levine and Zervos (1993) also suggest that the cross-sectional correlation amid inflation and economic activity is fragile. However, their results support the view that the time averaging of the series may be responsible for this lack of cross-sectional correlation. For example, using averages of 30 years or more may well obscure the influence that inflation dynamics may exert on economic activity.

Households and firms in countries which have experience a history of price stability may well consider inflation as an unimportant issue for their decision making in the allocation of recourses. On the other hand, countries which have experienced a long history of persistent inflation and inflation crisis may well be insensitive to the variations and volatility of prices. For instance, from 1970 to 2010, Brazil and Argentina experienced an average inflation exceeding 100% when taking into account the number of years these economies experienced hyperinflation crisis; however, their average growth during this period was 1.9% and 1.2% respectively, while the region average was 1.7%. In that order, this example in the region do shows that despite a high inflation these economies managed to achieve a relatively moderate growth as other economies which were characterized by price stability. Therefore, averaging inflation and economic growth performance over long time horizons may well obscure the dynamics between output growth and inflation.

Unspecified nonlinearities is also suggested as another reason for the lack of cross-sectional correlation amid inflation and output growth (Levine and Zervos, 1993). However, it may also be the case that cross-sectional models of economic growth may not be very informative about fluctuations in the main macroeconomic variables. For example, contrary to the evidence presented in

[238] In addition to the standard set of control regressors, we also control for regional dummies, that is, countries located in North and Central America, the Caribbean and South America. Moreover, we also control for the level of financial development in these economies as evidence suggest inflation is more harmful in countries with less developed financial systems (Rousseau and Wachtel, 2002).

other studies with respect to the lack of cross-sectional correlation amid output growth and inflation, Kormendi and Meguire (1985) do find that inflation negatively affects output growth in a cross sectional sample of forty seven countries during the post-war period from 1950 to 1977. Their results support the view of Stockman (1981) where in a cash-in-advance model additional anticipated inflation lowers economic growth by reducing the steady-state capital stock.

The findings presented in this chapter also reach a similar conclusion for Latin America. Despite the initial statistical insignificance of the cross-sectional correlation amid inflation and economic activity in the region, the growth effects of inflation are clearly negative ex-post the inflation threshold, and insignificantly positive before the threshold. In our view, the growth effects of inflation lower than the threshold may be operating through the Tobin-Mundell effect where anticipated inflation may reduce the real interest rate and hence boost growth (Mundell, 1963, Tobin, 1965). However, the negative growth effects of inflation higher than the threshold may be operating through the Stockman’s effect where anticipated inflation leads to lower growth via an increase in the costs of holding money which deteriorate investment and ultimately reduces the steady-state capital stock of the economy (Stockman, 1981). The unfolding of these dynamics may not be properly disentangled in a cross-sectional model and therefore our results calls for more robust threshold estimation methods. In what follows, we reinforce our findings by implementing more robust threshold estimation procedures to clarify our results.

4.4.3 Inflation thresholds estimation and testing

An underlying limitation of the spline function approaches is that the researcher has to conduct a grid search over potential inflation thresholds and determine whether these are statistically significant in the estimations. For this task however the evidence suggests that the within-groups estimator could be biased due to the presence of initial income as an endogenous regressor (Nickell, 1981, Durlauf et al., 2005)[239]. In addition, instrumental

[239] An alternative approach would be to exclude initial income from the model. Caselli et al. (1996) pursued this approach and found that the bias of the estimates is

variables estimations of spline function models appear inappropriate due to the often vague interpretation of R-squared in the two-stage least squares estimates[240]. To overcome these limitations we implement the Hansen (1999, 2000) and Kremer et al. (2013) threshold estimators[241]. These estimators offer the key advantage that the threshold is estimated by the model rather than being specified the researcher. This facilitates the threshold estimation when the location or point estimate of the threshold is unknown to the researcher.

Let us start with the estimation and testing for inflation thresholds in a non-dynamic panel setting. This approach will allow us to verify the inflation threshold when we exclude initial income as a regressor from the model. In addition, it will add additional robustness to our results when comparing our threshold estimates with those obtained from a dynamic panel threshold model. First, we establish the existence of an inflation threshold through a formal test for threshold effects. For this aim we implement the Hansen (1996, 2000) heteroskedasticity-consistent Lagrange multiplier test for a threshold in a balanced panel of eleven Latin American economies from 1960 to 2010[242]. The point estimate and test for the inflation threshold is given by the estimation of Eq. (4.6) via the Hansen (1999, 2000) threshold estimation approach applied to a non-dynamic panel data set.

Table 4.5 presents the point estimate, confidence interval and threshold test for inflation. Figure 4.3 presents the likelihood ratio sequence in Tau ($\hat{\tau}$)

---

relatively large when excluding initial income from growth regressions or not accounting for its endogeneity.

[240] Recall that in the spline function approach the possible structural break in the relationship or threshold between inflation and economic growth may occur at the inflation rate that minimizes the sum of squared residuals or that maximizes the R-squared of the model. However, in the two-stage least squares estimations the R-squared of the model has no consistent interpretation and its value could be negative (Wooldridge, 2012).

[241] We are grateful to Bruce Hansen and Alexander Bick for providing the Stata and Matlab codes for the threshold estimators. These codes are available from the web homepages of these authors.

[242] Since Hansen methods are designed for balanced panels with no gaps in the data, due to data availability we used a balanced panel subsample of our Latin American dataset. We test for a single threshold as we do not find significant evidence in favour of multiple thresholds nor in the data nor in our spline function estimations. Due to mild evidence of heteroskedastic errors in our estimations we use the heteroskedastic robust version of the test. In addition, we implement the bootstrap procedure outlined by Hansen (1996, 1999) using the default 5000 bootstrap replications (Hansen, 2000).

as a function of inflation as threshold variable. The point estimate for the threshold is the one that minimizes this likelihood ratio sequence, that is $\tau = 2.980$ or equivalently an inflation rate of 19.7%[243]. At the 95% critical value we reject the null hypothesis of no threshold effects. The rejection of the linearity hypothesis indicates the presence of threshold effects and nonlinearities in the relationship between inflation and economic growth in Latin America.

The asymptotic 95% confidence interval for the threshold estimate lies within the range of [19.7% - 21.36%]. This estimate is conservative and reflects little uncertainty about the threshold value. However, it lies outside our initial threshold estimate of 14% given by our spline function estimations. An initial concern is that the exclusion of initial income and other possible omitted variables may play a determinant role in the non-dynamic panel threshold estimates.

As a robustness to additional explanatory variables, we re-estimate Eq. (4.6) extending the set of control regressors to include the initial income in 1960, a measure for financial development in the form of domestic credit to the private sector, and a measure for banking and currency crisis to control for periods of macroeconomic stress[244]. Our results show that the point estimate for the inflation threshold increases and its confidence interval uncertainty rise (see Table B.6 in Appendix B). Our findings suggests that countries which have experienced periods of macroeconomic crisis despite having moderate levels of financial development may be characterized by a higher inflation threshold than countries which have experienced a history of low and stable inflation.

[243] Since τ is in logarithms the point estimate for the inflation threshold is $\tau = e^{2.980}$ which approximates 19.7%.

[244] Despite that these methods are designed for non-dynamic panels, we decided to follow Hansen (2000) lead and included initial income in 1960. Note that the measure for initial income clearly differs from that of initial income in 1960. The later refers to the level of income of each country in 1960, while the former considers the level of income of each country at the start of each five-year interval.

Table 4.5
Panel threshold estimation and testing

Threshold estimates and confidence intervals			
Threshold estimate	19.70%		
95% confidence interval	[19.70-21.36]		
Joint R-Squared:	0.55		
Test for threshold effects			
Threshold estimate (logs)	2.980	Number of bootstrap replications	5000
LM-test for no threshold	24.240	Trimming percentage	0.15
Bootstrap p-value:	0.0004	Observations	110
		Number of countries	11

Notes: Panel threshold estimation and testing (Eq. 4.6). The sample is a balanced panel of eleven Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in five-year averages. The heteroskedasticity-consistent Lagrange multiplier test for a threshold is that of Hansen (1996, 2000). The null hyphotesis is no threshold effects. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). Each regime contains at least 5% of the observations (Hansen, 1999). The control regressors are investment, population growth, terms of trade growth and volatility, trade openness growth and volatility.

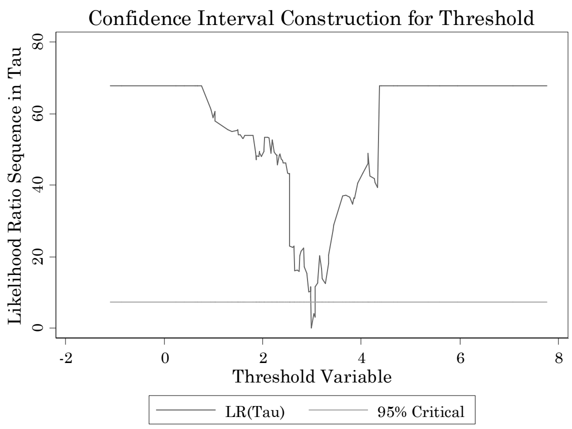

Fig. 4.3. Point estimate and confidence interval construction for the inflation threshold in a panel data setting. *Notes:* Threshold estimation in a panel data setting (Eq. 4.6). The sample is a balanced panel of eleven Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in five-year averages across the sample period. The threshold estimate approximates 19.7%.

To address the influence that high inflation observations and outliers may exert in the estimations, we follow Bruno and Easterly (1998) and estimate Eq. (4.6) for the countries that have experienced inflation rates less than 40% during the sample period[245]. Our findings suggest that low inflation countries have a lower threshold than countries which experiences high inflation[246]. By high inflation we refer to double digit inflation rates or more. Once we control for high inflation episodes and potential outliers, the threshold estimate in the non-dynamic panel setting (15.48%) is well close to that proposed by the spline function estimations (14%). In addition, we conducted a variety of robustness checks to verify the statistical significance of the inflation threshold under different scenarios and found that including additional explanatory variables, modifying the time window or increasing the number of countries does not change our main results[247].

To address the lack of cross-sectional evidence amid inflation and economic growth in Latin America, we estimate a cross-sectional threshold model following closely the threshold estimation and testing procedures outlined by Hansen (2000). In particular, we estimate Eq. (4.5) and use a cross-sectional variant of the data where we examine twenty-four Latin American economies from 1970 to 2010 with no missing values in the data. Table 4.6 reports the threshold estimation and testing results for the cross-sectional sample of Latin American economies. Regression (1) in Table 4.6 shows that the threshold estimate (12.9%) is quite close to the inflation threshold suggested by the spline function model (14%). However, in this case the heteroskedasticity-consistent Lagrange multiplier test for a threshold fails to reject the null hypothesis of no threshold effects at conventional levels of statistical significance. This preliminary result, in accordance with our previous finding in the spline function model, actually implies the inexistence of nonlinearities and threshold effect in the cross-section of Latin American economies.

---

[245] Due to data availability the total number of countries considered in the sample decreased from eleven to five. Nevertheless, reducing the number of time periods to increase the number of countries with no missing values available in the sample does not change our findings. Note that the statistics for many of the Latin American economies are not available for the years prior to the 1980's

[246] Our results are also shown in Table B.6 (Appendix B).

[247] See Table B.7 in the Appendix B.

Table 4.6
Cross-sectional threshold estimation and testing

	(1)	(2)
Threshold estimates and confidence intervals		
Threshold estimate	12.93%	14.41%
95% confidence interval	[12.93-13.75]	[14.41-14.41]
Joint R-squared:	0.73	0.91
Test for threshold effects		
Threshold estimate (logs)	2.621	2.668
LM-test for no threshold	7.687	14.041
Bootstrap p-value:	0.834	0.106
Number of bootstrap replications	5000	5000
Trimming percentage	0.15	0.15
Number of countries	24	24

Notes: Threshold estimation and testing in a cross-sectional setting (Eq. 4.5). The sample is a cross-section of Latin American economies from 1970 to 2010. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in long run averages from 1970 to 2010 averages. The heteroskedasticity-consistent Lagrange multiplier test for a threshold is that of Hansen (1996, 2000). The null hyphotesis is no threshold effects. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). Each regime contains at least 5% of the observations (Hansen, 1999). The control regressors in estimation (1) includes the investment share, population growth, terms of trade growth and volatility, trade openness growth and volatility. Estimation (2) adds as control regressors the domestic credit to the private sector and a measure of banking and currency crisis.

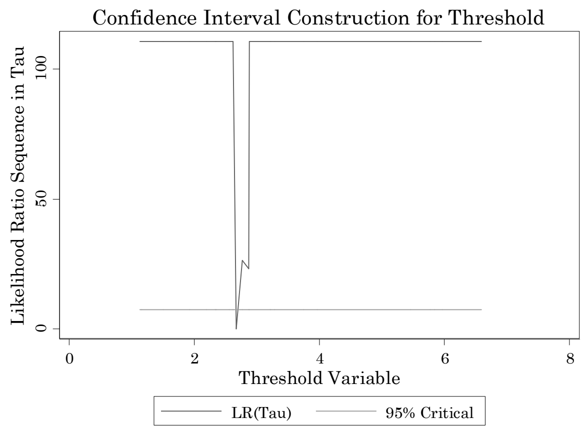

Fig. 4.4. Point estimate and confidence interval construction for the inflation threshold in a cross-sectional setting. *Notes:* Threshold estimation in a cross-sectional setting (Eq. 4.5). The threshold estimate is 14.41% and proceeds from regression (2) in Table 4.6. The sample is a cross section of twenty-four Latin American economies from 1970 to 2010. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in averages from 1970 to 2010.

Our view on the lack of cross-sectional correlation amid inflation and economic activity is that it may possibly originates from the time averaging of the series over 30 years or more. The long-run average of the series may obscure inflation and output growth trade-offs in the short-term to medium-term as well as obscuring inflation and growth performance in periods of macroeconomic distress (Levine and Zervos, 1993). To address these concerns, we re-estimate the cross-sectional threshold model of Eq. (4.5) while controlling for financial development in the form of domestic credit to the private sector, and controlling for periods of macroeconomic crisis using a measure of banking and currency crisis as described in our data section. In this way, the model accounts for both for the role of financial development and macroeconomic imbalances in periods of price stability and persistent inflation.

Estimation (2) in Table 4.6 suggests that once controlling for financial development and macroeconomic crisis in the cross-sectional threshold model, the null hypothesis of no threshold effects is marginally rejected at the 10% to 11% significance level. In that order, Figure 4.4 shows that the threshold estimate is located at approximately 14.4% with a 95% confidence interval. In addition, the estimated threshold (14.4%) in the cross-sectional model is quite similar to that of the spline function model (see Table 4.4 and Figure 4.2). Moreover, these estimates are relatively close to the threshold estimate (19.7%) proposed by the non-dynamic panel threshold model in Table 4.5. What these results may imply is that accounting for macroeconomic crisis and financial development may be an important factor in determining the cross-sectional correlation and nonlinear effects of cross-sectional inflation-growth models, particularly in countries that have been characterized by sustained periods of macroeconomic imbalances and persistent inflation such as the Latin American economies.

In what follows our primary focus will be on the dynamic panel data estimation of threshold models in order to exploit the cross-sectional and time series variation of the data. This approach may prove more informative about nonlinearities and threshold effects in the inflation-growth nexus since our findings in the cross-sectional threshold model and in the non-dynamic panel threshold model are quite similar to those obtained from the spline function model.

Let us now address the endogeneity issue of initial income in the threshold estimation and testing. Including initial income as a regressor in the model yields by construction a dynamic panel threshold model of the type described by Kremer et al. (2013). This class of dynamic panel threshold models builds on Hansen (1999) distributional theory for panel data models with country specific effects and Caner and Hansen (2004) instrumental variables estimation procedures for a threshold models with endogenous regressors. A distinguishing feature of the Kremer et al. (2013) threshold estimator is that it allows for the consistent estimation of the threshold in the presence of a lagged dependent variable, an endogenous regressors and individual's specific effects[248].

We proceed to the estimation of an unknown threshold in a dynamic panel threshold model with individual countries specific effects and initial income as an endogenous regressor and lagged dependent variable[249]. For this aim, consider the estimation of Eq. (4.7) via the Kremer et al. (2013) dynamic panel threshold estimator[250]. Our sample is a balanced panel of eleven Latin American economies from 1960 to 2010. Following Durlauf et al. (2005) and Roodman (2009b) our primary specification uses lagged levels of initial income up to the fifth lag as instruments. As in Hansen (1999), each regime contains at least 5% of the observations such that a standard minimal amount of observations are considered in each regime. We account for

[248] Although this class of estimators is consistent we make no claim that it is more efficient than other classes of threshold estimators. In addition, note that these classes of threshold models allow for a single threshold specification where the threshold variable is assumed strictly exogenous. Extending these models to consider multiple thresholds and an endogenous threshold variable would be an interesting topic for future research.

[249] Despite that the dynamic panel threshold estimator does not extend to the case of an endogenous threshold variable, we tested for the possible endogeneity of the inflation function (threshold variable) and other regressors in a two-stage least square instrumental variables estimation of Eq. (4.1) and Eq. (4.2). Our findings suggest that we can treat the threshold variable and the control regressors as exogenous in the model.

[250] Our initial evidence favours the specification of individuals and time period specific effects to control for potential unobserved heterogeneity and common specific shocks to these economies. The influence of time-invariant unobserved heterogeneity is eliminated via the forward-orthogonal deviation transformation which removes fixed effects in the model (Arellano and Bover, 1995). However, including time period specific effects in the dynamic panel threshold model does not change our main findings. These results are available from the author upon request.

differences in regime intercepts as the evidence suggests it may improve the threshold estimation (Bick, 2010, Kremer et al., 2013).

Table 4.7 presents our main results for inflation thresholds and economic growth in Latin America. We find significant evidence of an inflation threshold at an inflation rate of 14.07%. The 90% confidence interval is conservative and asymptotically valid suggesting that the threshold estimate is located within the inflation range between 13.92% and 15.08%. Note that this interval contains already our previous estimate for an inflation threshold of 14% given by the spline function estimations (Eq. 4.2) already presented in Table 4.4 and Figure 4.2. In addition, this interval range is quite close to the threshold estimate (19.7%) proposed by the non-dynamic panel threshold model (Eq. 4.5) presented in Table 4.5 and Figure 4.3. Moreover, it already contains the estimated inflation threshold (14.4%) reported by the cross-sectional threshold model presented in Table 4.6 and Figure 4.4. These findings bring confidence that our results are consistent across different econometric methodologies, selection of countries and different time windows[251].

The marginal growth effects of inflation below and above the threshold are given respectively by the coefficients of $\widehat{\beta_1}$ and $\widehat{\beta_2}$. We find that low and moderate inflation significantly correlates with higher economic growth in Latin America. By keeping inflation below its threshold value, the Latin American countries may grow faster. The coefficient $(\widehat{\beta_1} = 0.624)$ is highly significant indicating that inflation rates below 14% improve economic activity. A by-product of this finding is that by sustaining relatively low levels of inflation, the Latin American economies may forfeit economic growth. In other words, developing countries that maintain low levels of inflation may experience slower growth rates, or in other words the output cost of disinflation in low inflation countries may be high.

[251] Our findings are robust to alternative instrument count, modifications in the time period, outlier's sensitivity and additional explanatory variables (see Table B.8 in Appendix B).

Table 4.7
Inflation threshold and economic growth in Latin America

Threshold estimates and confidence intervals			
	Estimate	Confidence interval (90%)	
Threshold ($\hat{\tau}$)	14.07%	[13.92-15.08]	
Regime dependent regressors		Regime independent regressors	
$\widehat{\beta_1}$	0.624***	Initial income	-2.207**
	(0.214)		(0.960)
		Investment	2.285***
$\widehat{\delta_1}$	-0.715		(0.930)
	(1.036)	Population growth	-1.389***
			(0.270)
$\widehat{\beta_2}$	-0.455**	Terms of trade growth	0.224***
	(0.251)		(0.035)
		Terms of trade volatility	-0.002
			(0.023)
Observations	110	Trade openness	-1.028*
Number of countries	11		(0.614)
		Trade openness volatility	2.783
			(4.334)

Notes: Dynamic panel threshold estimation (Eq. 4.7). The sample is a balanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The threshold variable is the inflation function. The unit of observations is in five-year averages. The initial income is considered as the endogenous regressor and its lagged levels up to the fifth lag are used as instruments. Each regime contains at least 5% of the observations (Hansen, 1999). Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

After inflation has exceeded its threshold level there is a robust negative and significant correlation between inflation and economic growth. The coefficient $(\widehat{\beta_2} = -0.455)$ is significantly negative indicating that high inflation is harmful to economic activity. The marginal cost of inflation increase at higher inflation rates as inflation has a detrimental impact on economic growth. Overall, we find that the growth effects of inflation are statistically significant. The threshold effect is significant, and the growth effects of inflation below and above the threshold are significantly different.

The estimates for the regime independent regressors (control variables) are in line with previous findings in the empirical growth literature (De Gregorio, 1992a, b, Levine and Renelt, 1992, Durlauf et al., 2005, Astorga, 2010). Our findings suggests insignificant evidence in favour of accounting for differences in regime intercepts, however we follow Bick (2010) and Kremer et al. (2013) by including these in the estimations and maintain the comparability of our results while reducing the potential bias that may be cause by omitting these from the estimation.

Our evidence favours the view that the growth effects of low and moderate inflation are significantly different from those of high inflation[252]. Therefore, inflation has differentiated growth effects on economic activity. This finding is also supported by the spline function estimations, the cross-section threshold model and the non-dynamic panel threshold model which also indicates the presence of structural breaks and nonlinearities in the inflation-growth nexus.

We extend the model of Eq. (4.7) to control for financial development and macroeconomic crisis (see Table B.8 in Appendix B). This appear a plausible approach since arguments could be made that macroeconomic instability may fuel the effects of inflation on output, and that financial development may dampen the growth effects of inflation on economic activity by providing economic agents with financial instruments to hedge against raising prices. In that order, we use domestic credit to the private sector as a measure for financial development, and banking and currency crisis to account for periods of macroeconomic instability[253]. In addition, we vary the endogenous regressor instrument count and reduce the time window to account for the recent Latin American growth history since the 1980's. This latter approach allow us to increase the number of countries available in the sample from eleven to seventeen, as for many Latin American economies data for the explanatory variables is not readily available for the years prior the 1980's.

Our findings remain relatively invariant after we control for increases in the money supply, financial development, macroeconomic crisis, modifications to the time period and additional number of countries (see Table B.8 in Appendix B). The results suggest that increases in the money supply do not significantly drive economic growth nowadays in Latin America. This

---

[252] For the case of the Latin American economies we consider that high inflation is characterized by inflation rates exceeding 20% per year. In that order, moderate inflation levels are considered between 10% and 20% per year while low levels of inflation are those characterized by single digits inflation rates. We follow the definitions of inflation crisis proposed by Reinhart and Rogoff (2009).

[253] Recall that our measure of domestic credit to private sector is provided by the World Development Indicators from the World Bank. We compute the measures for banking and currency crisis following Laeven and Valencia (2010, 2012) and Reinhart and Rogoff (2009, 2010).

coincides with the structuralist view of inflation and output growth for the region (Baer, 1967, Fischer and Mayer, 1980, Boianovsky, 2012). However, this finding may well be influenced by the period of macroeconomic moderation in terms of inflation and economic growth experienced by the Latin America economies since the second half of the 1990's until the recent global financial crisis which started in 2008 where counter-cyclical fiscal and monetary policies—as well as inflation targeting regimes—were adopted by many of the Latin American economies[254].

Another result from our estimations is that since the 1980's the detrimental effects that inflation higher than the threshold exerts on output growth appears to be statistically insignificant. This coincides with the observation that for many Latin American economies inflation has been relatively stable and predictable since the second half of the 1990's. In this case, economic agents in these economies may have designed instruments to deal with high inflation in which case despite of being negatively related to output growth it may have to reach extreme values for economic agents to modify their allocation of resources. Our findings also show that the selected measure for financial development (domestic credit to the private sector) appears in some specifications negatively correlated with economic growth although the effect is insignificant. This may suggest the possible allocation of unproductive credit in the Latin American economies. Another explanation is that for some of these countries the measure of domestic credit already includes credit provided to partly public enterprise in which case the use of credit may be unproductive[255].

The confidence intervals of the threshold estimates increases after controlling for macroeconomic crisis and reducing the time period. This is more likely to be due to the severe inflation crisis experienced by many of these economies during the debt crisis in the 1980's and the macroeconomic imbalances originated from various import-substitution industrialization policies during the 1960's and 1970's (Baer, 1972, 1984).

Our estimates for the inflation threshold (14%) in Latin America are in line with other estimates of inflation thresholds proposed for developing

---

[254] For a discussion on these issues see Ocampo (2009).

[255] A partly public enterprise may be characterized by shared ownership between the private sector and the government. See Franko (2007) for a discussion on the inefficiencies of state-owned and partly public enterprises in Latin America.

countries[256]. However, the results from our dynamic panel threshold models indicate that inflation lower than the threshold correlates significantly with higher output growth. On the other hand, inflation higher than the threshold correlates significantly with lower output growth. We suggest that low inflation countries may have a lower inflation threshold than countries with a history of high and persistent inflation. In addition, our results are robust to additional explanatory variables, outlier's sensitivity, and modification in the instrument count and changes in the time period.

While it is nowadays generally accepted the view that high inflation deteriorates economic activity, the evidence concerning the benefits of low inflation on economic activity has been less convincing. For example, Fischer (1993) do suggests that low inflation may drive faster growth, and Khan and Senhadji (2001) indicates that stable prices improve economic performance. However, others studies such as Bruno and Easterly (1998) suggests that no significant relationship exist between inflation and economic growth at low and moderate inflation rates, while others studies such as Kremer et al. (2013) suggests a positive but statistically insignificant correlation between inflation and output growth. In any case, there is general agreement that the output costs of disinflation may be high in low and moderate inflation countries which is a view also supported by our results[257].

For the Latin American economies the evidence presented in this chapter clearly indicates that low inflation before the threshold significantly improves economic activity, while inflation exceeding the threshold is detrimental to output growth. In what follows, we also contribute to the existing literature on inflation and economic growth by examining the role of fiscal policy in the

[256] For example, Fischer (1993) proposed an initial inflation threshold for all countries at an inflation rate of 15%. Ghosh and Phillips (1998) found evidence of a possible inflation threshold at 10%. In an examination of 140 countries from 1960 to 1998, Khan and Senhadji (2001) documents an inflation threshold between 11% to 12% for developing countries. Drukker et al. (2005) find evidence of a 19% inflation threshold in their sample of 142 economies from 1950 to 2000. In a study of 40 countries from 1960 to 2004, Bick (2010) also give evidence in favour of an inflation threshold at around 12%. Using a large sample of 165 countries from 1960 to 2007, Espinoza et al. (2010) found evidence of an inflation threshold located at an inflation rate between 7% to 13%. Kremer et al. (2013) suggests a 17% inflation threshold for developing countries in a sample of 124 economies using data spanning from 1950 to 2004.

[257] For a discussion on the output costs of disinflation in Latin America see the works of Dornbusch and Fischer (1993) and Hofstetter (2008).

determination of nonlinearities and threshold effects in the inflation-growth nexus in Latin America.

4.4.4 The role of fiscal policy on inflation thresholds

An important question in the estimation of inflation thresholds is how the inclusion of fiscal policy in the model may influence the point estimate of the threshold, its confidence interval and statistical significance level. Our concern is on whether the threshold effects of inflation remain significant after controlling for fiscal policy. In other words, on whether the growth effects of inflation may be operating through the channels of fiscal policy.

A branch of the existing literature suggests a robust theoretical and empirical relation amid fiscal policy, economic growth and inflation in developing countries. Using cross-sectional and historical data spanning approximately 100 countries from 1870 to 1988, Easterly and Rebelo (1993) finds that the central government budget surplus significantly correlates with higher growth, while most fiscal variables correlate with higher income, and government expenditures are negatively related to economic development. Fischer (1993) presents evidence indicating that growth, capital accumulation and productivity are correlated with good fiscal performance—budget surpluses—while these are negatively related to inflation. These results also appear to extend to advanced economies. In a sample of 22 OECD countries from 1970 to 1995, Kneller et al. (1999) finds that productive government expenditures drive economic growth, however non-productive expenditures are detrimental to economic activity.

Other studies relate fiscal policy directly to inflation performance. Using a dynamic autoregressive distributed lag model and the pooled mean group estimator for dynamic panels in a sample spanning 107 countries from 1960 to 2011, Catão and Terrones (2005) finds that fiscal deficits leads to higher inflation in developing countries. In addition, they propose a theoretical intertemporal optimization model where equilibrium inflation is directly related to fiscal deficit scaled by narrow money. Extending their results, Lin and Chu (2013) implements a dynamic panel quantile regression approach with an autoregressive distributed lag structure in a sample of 91 countries from 1960 to 2006 and concludes that fiscal deficits are inflationary in developing countries experiencing high and middle inflation episodes, while fiscal policy is not an issue in low inflation countries.

Despite the existing evidence on the potential role of fiscal policy on growth and inflation performance, several threshold models for inflation have overlooked the potential growth effects of fiscal policy (Sarel, 1996, Khan and Senhadji, 2001, Burdekin et al., 2004, Drukker et al., 2005, Bick, 2010, Kremer et al., 2013). These studies implicitly assumed that the growth effects of fiscal policy are being capture by the vector of control variables traditionally included in growth regressions.

To shed light on the question concerning the role of fiscal policy on inflation thresholds it would be interesting to verify whether the threshold remains statistically significant after controlling for analytical measures fiscal policy, and whether the point estimate and confidence interval of the threshold remains accurate and precisely estimated. For this aim—unlike previous studies—we extend the dynamic panel threshold model (Eq. 4.7) to incorporate two analytical measure of fiscal policy.

Following Easterly and Rebelo (1993) and Fischer (1993), our primary measure of fiscal policy is the budgetary central government cash surplus/deficit scaled by GDP[258]. The cash surplus/deficit proxies the fiscal performance and overall budget balance of the government. In addition, we also introduce the general government final consumption expenditures scaled by GDP as proxy for government size and expansionary fiscal policy (De Gregorio, 1992a)[259]. Our data for the fiscal policy variables proceeds respectively from the IMF's International Financial Statistics (IFS) and the World Bank's World Development Indicators (WDI).

Table 4.8 reports the dynamic panel threshold estimation of Eq. (4.7) accounting for fiscal policy in Latin America. Three main important results

[258] Our measure for the government budget balance is the budgetary central government cash surplus/deficit defined as inflows from operating activities minus cash outflows from investments in nonfinancial assets (IFS CCSD.BA) scaled by GDP (IFS line 99) in national currency. This measure is akin to the overall budget balance of the 1986 IMF's Government Finance Statistics manual, and to the cash surplus/deficit measure of the World Bank's World Development Indicators. Due to data availability for the Latin American economies we propose the budgetary central government measure.

[259] We use the general government final consumption expenditures (% of GDP) (NE.CON.GOVT.ZS) from the World Bank.

are worth of discussion. First, we find significant evidence of threshold effects in Latin America despite accounting for fiscal policy in the region. The threshold effect remains sizeable and significant. Employing the Hansen (1996, 2000) heteroskedasticity-consistent Lagrange multiplier test for a threshold we reject the null of no threshold effects at conventional levels of statistical significance. Second, the point estimate of the threshold and its confidence interval remains accurate and conservative. The estimate is located in the neighbourhood of the 14% inflation threshold. These results are in accordance with our previous findings presented in Tables 4.4, 4.6 and 4.7.

Surprisingly, our third finding indicates that the growth effects of inflation are statistically insignificant once we control for the government cash surplus/deficit to GDP as a measure for fiscal policy. Nevertheless, the growth effects of inflation are different beneath and beyond the inflation threshold. Beneath the inflation threshold, additional inflation is positively correlated with output growth. In contrast, inflation rates beyond the threshold are negatively correlated to economic activity. Note that despite the initial statistical insignificance of the growth effects of inflation while controlling for the cash surplus/deficit of the central government, the inflation threshold remains statistically significant at conventional levels.

The preliminary statistical insignificance of the growth effects of inflation is reverted once we account for the government consumption expenditures as a proxy for government size and expansionary fiscal policy. Inflation below the threshold now turns out statistically significant at conventional levels indicating that below the inflation threshold, low and moderate inflation correlate with higher output growth. However, beyond the threshold, inflation remains detrimental to economic activity and its growth effect appears statistically insignificant.

Table 4.8
Inflation thresholds and fiscal policy in Latin America

	(1)	(2)
Test for threshold effects		
LM-test for no threshold	18.014	24.926
Bootstrap p-value:	0.015	0.001
Threshold estimates and confidence interval		
Threshold ($\hat{\tau}$)	13.59%	14.07%
Confidence interval (90%)	[6.09-14.86]	[13.92-15.48]
Regime dependent regressors		
$\widehat{\beta_1}$	0.269	0.470*
	(0.319)	(0.298)
$\widehat{\delta_1}$	-0.319	0.635
	(3.026)	(1.538)
$\widehat{\beta_2}$	-0.627	-0.236
	(1.040)	(0.395)
Regime independent regressors		
Initial income	-1.440	-1.672
	(1.273)	(1.395)
Investment	1.877**	2.250**
	(0.969)	(1.087)
Population growth	-1.433***	-1.363***
	(0.235)	(0.359)
Terms of trade growth	0.193***	0.236***
	(0.041)	(0.042)
Terms of trade volatility	0.065	0.001
	(0.041)	(0.031)
Trade openness	-1.441	-1.274*
	(1.314)	(0.758)
Trade openness volatility	2.325	6.592
	(7.072)	(5.229)
Government cash surplus/deficit to GDP	15.237	
	(15.382)	
Government consumption to GDP		-0.487
		(0.698)
Observations	50	100
Number of countries	5	10

Notes: The sample is a balanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The threshold variable is the inflation function. The unit of observations is in five-year averages. The heteroskedasticity-consistent Lagrange multiplier test for a threshold is that of Hansen (1996, 2000) via the panel data estimation of Eq. (3) extended with the fiscal variables. The null hyphotesis is no threshold effects. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). To obtain the bootstrap p-values we use 5,000 bootstrap replications with a trimming percentage of 15% from ends of the sample (Hansen, 2000). The threshold estimates and confidence intervals are obtained through the dynamic panel threshold estimation of equation (7) extended with the fiscal policy variables. The initial income is considered as the endogenous regressor and its lagged levels up to the first lag are used as instruments. Each regime contains at least 5% of the observations (Hansen, 1999). Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

An implicit yet important result from our estimates in the dynamic panel threshold model is that neither the government expenditures nor the cash surplus/deficit of the government are found to be major drivers of economic growth in Latin America while accounting for inflation thresholds. Both government expenditures and the cash surplus/deficit are found to be statistically insignificant. We included these in the estimation under the presumption that if fiscal policy drives inflation and economic growth, the inclusion of these fiscal measures should render the inflation threshold invalid and insignificant. This was not the case in our estimations as we clearly find significant evidence in favour of threshold effects in the inflation-growth nexus. In addition, the point estimates and confidence intervals of the threshold are in line with our previous results using different threshold estimation methods. Moreover, despite the inclusion of the fiscal measures, the point estimates of the control variables remain accurate except for the volatility measures which often appear with the opposite signs.

These findings should be interpreted with caution. First, the fact that some of the growth effects of inflation are found statistically insignificant while controlling for fiscal policy appears to reinforce the view that good fiscal performance is a key driver of macroeconomic stability and output growth in Latin America. However, the view that conservative monetary policy and fiscal discipline is essential for output growth and stable inflation is perhaps too restrictive (Fischer, 1993). In fact, in a recent examination of 44 economies from 1960 to 2011, Ilzetzki et al. (2013) finds that in open economies with an appropriate degree of exchange rate flexibility—such as the Latin American economies—expansionary fiscal policy does not lead to improvements in output growth. On the contrary, Engen and Skinner (1992) suggest that government expenditures and taxes are detrimental to economic activity but recognizes the potential important role of fiscal policy in the growth process. Second, due to data availability our sample of countries is constrained to five economies as international fiscal data for Latin America is quite limited. However, this has not only been an issue specific for Latin America but for other world regions as well[260]. The statistical relationship between fiscal policy, output growth and inflation is not only fragile in many

[260] On the limitations of international fiscal data see Fischer (1993) and Ilzetzki et al. (2011).

instances but sensitive to the choice of control variables, sample period and number of countries (Easterly and Rebelo, 1993).

To improve on these limitations we proceed to reduce the time period in the sample from the 1960's to the 1980's. Reducing the number of time periods allow us to increase the number of available observations for each country as the international data coverage for the Latin American economies increases after the 1980's. This approach improves the number of countries from five to ten and to sixteen economies. We then proceed to test for threshold effects via the Hansen (1996, 2000) heteroskedasticity-consistent Lagrange multiplier test for a threshold. For this aim, we estimate the panel threshold model (Eq. 4.6) extended with the fiscal measures. Our findings presented in Table B.9 (Appendix B) show that we can reject the null of no threshold effects at conventional levels of statistical significance. However, in one scenario we fail to reject the null hypothesis of no threshold effects when we account for the government consumption expenditures during the period from 1980 to 2010.

In an extension of our results, we further examine the cross-sectional variation amid inflation, economic growth and fiscal policy in Latin America over the period from 1970 to 2010. Table B.10 in Appendix B reports our findings which suggest that despite the growth effects of inflation are less significant while accounting for fiscal policy in the region, the inflation threshold remains statistically significant and accurately estimated when controlling for government consumption expenditures as a proxy for fiscal policy. Previously, we were unable to widely detect threshold effects in a cross-sectional setting (see Table 4.6), however once we account for government consumption expenditure then the statistical significance of the inflation threshold increases and brings additional robustness to the cross-sectional estimation of the inflation threshold. It is important to note that our estimates and confidence interval construction for the cross-sectional threshold while accounting for fiscal policy are in line with our previous results[261]. In fact, Table B.10 indicates that the 95% confidence interval construction for the inflation threshold is located at an inflation rate amid 14% to 15%. This finding brings additional confidence in the correct estimation of the inflation threshold for Latin America.

[261] See our findings presented from Table 4.4 to Table 4.8.

Considering the possible limitations of our fiscal data, we further improve the robustness of our results by implementing different econometric methods which handles unbalanced panels. In this case, both the number of cross-sectional units and number of observations available in sample increase. First, we estimate the standard growth model proposed by Eq. (4.1) extended with the fiscal variables. Our aim is to show there is a robust nexus between inflation and economic growth in Latin America despite accounting for fiscal policy. As suggested by the structuralist view of inflation in the region, inflation may be driven by other structural and socio-economic rigidities in the Latin American economies aside that steaming from uncontrolled increases in the money supply and expansionary fiscal policy (Baer, 1967, Boianovsky, 2012).

Table B.11 (Appendix B) reports our robustness checks for econometric methodology, outlier's sensitivity and additional explanatory variables in the inflation-growth nexus in Latin America while accounting for fiscal policy. We carried out the estimations via the within-groups estimator and the two-stage least squares estimator with time and country specific effects[262]. Our findings indicate a robust negative and significant trade-off between inflation and economic growth across all inflation levels (see Table B.11).

The government cash surplus/deficit to GDP is found to be statistically insignificant and often appears with the opposite predicted sign in some of the estimation. The interpretation for the coefficient sign of the fiscal measures appears ambiguous. For instance, a restrictive fiscal policy in an inflationary environment may yield a budget surplus and reduce inflation at the expense of curtailing growth. In this case the coefficient may be negative. However, a sustainable fiscal policy may result in budget surpluses and price stability yielding a sustainable economic growth, and in this case the coefficient may be positive. Therefore, we view the results from Table B.11 as suggesting that in the context of an inflationary environment contractionary fiscal policy leading to budget surpluses reduces output growth and curtail inflation, while in low inflation countries conservative fiscal policy and budget surplus leads to improvements in economic activity.

---

[262] In the instrumental variables estimation initial income is specified as the endogenous regressor. We use alternative lag choices of the endogenous variable as a robustness to instrument count (Roodman, 2009b).

The government consumption expenditures appears to be a better measure of the fiscal stance as it is statistically significant at conventional levels in most of our estimations. This finding brings supports the Barro (1991) and De Gregorio (1992a) view that government consumption is an important determinant of economic growth. On the other hand, the rate of money growth is found to be statistically insignificant and does not add much explanatory power to the model once accounting for fiscal policy. This may bring support to the money neutrality hypothesis. Nevertheless, it is important to observe that money growth often appears insignificantly correlated with higher output in many estimations, and this may cast doubt on the money neutrality hypothesis for economic growth in Latin America. For example, if the government finances investment projects by seigniorage and monetization of the deficit, whether this actions will improve or not economic growth may largely depends on how productive will be these expenditures.

Our estimation approach for the robustness checks offer the key advantage that unlike the panel threshold estimators which requires a balanced panel dataset with no gaps in the data, the within-groups and two-stage least squares estimators handles unbalanced panels with possible missing values and therefore our sample of countries increase from initially ten economies to approximately seventeen to twenty-one Latin American countries. The exact number of countries included in the estimations largely depends on the model specification and choice of control regressors due to data availability.

Following the approach described previously, the question remains on whether the inflation threshold prevails under different econometric methods while controlling for fiscal policy. Table B.12 reports the robustness to alternative econometric methodology, outlier's sensitivity and additional explanatory variables in the threshold estimations while accounting for fiscal policy in Latin America. For this aim, we estimate the spline function model (Eq. 4.2) extended with the fiscal variables under the setting of a single threshold at a 14% inflation rate[263]. Our results suggest the presence of

---

[263] Recall that we do not find significant evidence in favour of multiple inflation thresholds in the Latin American economies. We do find insignificant evidence of tentative thresholds within the range between 2% and 7% inflation rate. Other potential thresholds may be located at prohibitively high inflation rates that would exceed 30% per year.

insignificant threshold effects of inflation across all inflation rates while controlling for fiscal policy. In addition, some of the control regressors and fiscal measures often appear with the opposite predicted sign.

A concern when estimating this type of models across all inflation rates is the potential role that outliers and high inflation observations may play in the threshold estimations. Extreme observations in the threshold variable—inflation—may have distortionary effects in the point estimates of the threshold. As a robustness to outliers sensitivity, we follow Bruno and Easterly (1998) and estimate the standard growth model (Eq. 4.1) and the spline function model (Eq. 4.2) for the cases where the rate of inflation is less than 40% in each country. Our estimates from Eq. (4.1) show there is an overall negative but statistically insignificant relationship between inflation and economic growth when nonlinearities and threshold effects are not specified in the estimation (Table B.11 in Appendix B). In contrast, when we account for the presence of threshold effects in the spline function estimates (Eq. 4.2) we do find evidence in favour of thresholds effects and nonlinearities in the inflation growth nexus when controlling for government consumption expenditures (Table B.12). In other words, once controlling for high and influential inflation observations, we do not find significant evidence in favour of the growth effects of inflation while accounting for fiscal policy across all inflation levels. However, when we allow for a nonlinear threshold specification in the inflation growth nexus, we find evidence of significant threshold effects of inflation despite controlling for high inflation, fiscal policy and increases in the money supply. Given the threshold specification, we found that inflation is positively but statistically insignificant correlated with output growth. However, an inflation rate that exceeds the threshold has a significant detrimental impact on economic activity.

Our view from the results presented in the robustness checks to different econometric methods and outliers sensitivity indicate there is an overall negative but insignificant relationship between inflation and economic growth while accounting for fiscal policy in Latin America. However, when addressing nonlinearities and threshold effects in the inflation-growth nexus there is evidence which favour the hypothesis of threshold effects and unequal growth effects of inflation at different inflation rates. In multiple estimations these threshold effects are statistically significant despite accounting for fiscal policy. These results are important in the sense that the apparent insignificant correlation between output growth and inflation found in many studies may be due to unspecified nonlinearities and thresholds effects in the inflation growth nexus.

Another issue in the study of fiscal policy and inflation thresholds is the potential correlation among the fiscal measures, inflation (threshold variable) and economic growth (dependent variable). To address this issue we included the government consumption expenditures as an alternative specification for fiscal policy. Government consumption is an important determinant of economic growth and a measure of government size and expansionary fiscal policy which do not necessarily leads to higher inflation as the sources of the government financing needs to be considered when determining how governments finance their consumption expenditures[264]. In other words, a balanced budget may lead to higher consumption expenditures and output growth without necessarily implying raising prices. Therefore, the measure for government consumption expenditure is less correlated to inflation and output growth than other fiscal measures, and may be a better proxy for the fiscal stance[265].

Overall our findings indicate that the growth effects of inflation do not necessarily ascribe to fiscal policy issues as raising prices may occur in the presence of fiscal discipline. Despite controlling for fiscal policy, we do confirm the existence of an inflation threshold in the neighbourhood of a 14% inflation rate. The growth effects of inflation beneath the threshold are positive however in many instances statistically insignificant. Beyond the threshold, inflation is found to exert a clear detrimental effect on economic activity.

---

[264] We neither find evidence suggesting we should specify the fiscal measures as endogenous in the model. Nevertheless, including the fiscal measure as endogenous regressors in our estimations does not change our qualitative results.

[265] In fact, the pairwise correlation coefficient of government consumption expenditures with inflation is relatively lower to that of the government cash/surplus deficit and inflation (see Table B.3 in Appendix B).

4.5 Conclusion

This chapter examines inflation thresholds and economic growth in 32 Latin American economies from 1960 to 2010. Our results show there is a nonlinear relationship between inflation and economic growth in Latin America. We document the existence of an inflation threshold located at a 14% inflation rate. Low to moderate inflation rates below the inflation threshold are found to be significantly correlated with higher output growth. However, our findings show that additional inflation that exceeds the threshold exerts significant negative effects on economic growth.

Our findings suggest as approximately 14% the level of inflation after which raising prices starts to distort economic activity in Latin America. In that order, an indirect implication of our results is that the output costs of disinflation may be substantial at low to moderate inflation levels. While nowadays the consensus in the existing literature is that inflation is overall detrimental to long-run growth, there is substantial disagreement with respect to the growth effects of inflation at low and moderate inflation rates (Fischer, 1993, Temple, 2000). Across many Latin American economies the implementation of inflation stabilization policies in order to maintain price stability at low inflation rates has resulted in substantial output losses (Kiguel and Liviatan, 1988, Hofstetter, 2008).

The results presented in this chapter also suggest that countries with a long history of high and persistent inflation may experience a higher inflation threshold than countries characterized by a history of low and stable prices. This is an interesting result derived from the comparison of our estimates for the inflation threshold after controlling for high inflation observations. In addition, with respect to the time period under investigation, the negative growth effects of inflation appear to be relatively lower in Latin America after the 1990's. This finding supports the view that the structural economic reforms implemented in many Latin American economies during the 1990's were successful in addressing many of the causes and consequences of high and persistent inflation (Bresser-Pereira, 1993, Morley et al., 1999).

Unlike previous studies on nonlinearities and threshold effects in the inflation-growth nexus—to the best of our knowledge—we are the first to investigate the role of fiscal policy in the determination of inflation threshold in the Latin American economies. Our results show substantial evidence in favour of nonlinearities and threshold effects in the inflation-growth nexus despite accounting for fiscal policy in the region. The inflation threshold estimate is also found to be located at nearly 14% once accounting for fiscal policy.

Some caveats are worth mentioning in the study of fiscal policy and inflation threshold in Latin America. First, the inflation threshold and the growth effects of inflation are found to be statistically insignificant in some specifications while accounting for the government cash/surplus deficit to GDP as a measure of fiscal policy. This may suggests that fiscal policy is an important channel and source of inflation in the region. However, once accounting for government consumption expenditures as an alternative fiscal policy measure, the inflation threshold and the growth effects of inflation remain statistically significant. As in De Gregorio (1992a), we find government consumption expenditures to be a major determinant of economic growth in Latin American.

Addressing many of the critiques to studies of inflation and economic growth studies outlined by Clark (1997), our results are shown to be robust to different econometric methods, additional explanatory variables, outlier's sensitivity, the incorporation of high inflation observations, modifications to the number of countries, and variations in the time window and the number of time periods under examination. In addition, as in Levine and Renelt (1992) and Bruno and Easterly (1998), we do find a lack of cross-sectional correlation between inflation and economic growth while discarding high inflation observations. However, once we account for nonlinearities and threshold effects in the inflation-growth relationship—as well as for fiscal policy—our findings show substantial evidence in favour of an inflation threshold and important growth effects of inflations at different inflation rates. These results suggests that the lack of cross-sectional correlation between inflation and economic growth found in many studies is likely to be due to unspecified nonlinearities and threshold effects in the inflation-growth relationship[266].

Surprisingly, our findings also indicate that the money supply is not a major determinant of economic growth and inflation in Latin America. In other words, money is found to be neutral for growth and inflation in the

---

[266] A similar view is also shared by Levine and Zervos (1993).

region. Despite accounting for increases in the money supply, our findings suggest that the inflation threshold and the growth effects of inflation remain statistically significant at conventional levels. It is important to re-emphasize that nowadays nonlinearities and threshold effects in the inflation-growth nexus are found to exist despite accounting for fiscal policy and increases in the money supply.

The results presented in this chapter favour the structuralist view of inflation in Latin America. According to this view, low to moderate inflation rates may be necessary at an early stage of the development process in order for expansionary economic policies to drive a faster economic growth that may lead to industrialization. At a later stage of development, reforms to the structural and socioeconomic rigidities that are the main causes of inflation in these economies will render price stability with a sustainable economic growth and development[267]. In that order, various of the structural reforms undertaken by many Latin American economies during the 1990's were seen as successful in improving economic growth in the region with additional price stability (Easterly et al., 1997).

An important economic policy recommendation for Latin America is that price stability should be maintained across countries, however not at all costs. The output cost of disinflation at low and moderate inflation rates can be substantial. For moderate inflation rates we refer to increases in the end-of-period consumer price index of no more than 14% each year, while for low inflation rates we refer to single digit inflation. The results of this chapter favours the view that Central Banks in the region may exceed temporarily their inflation targets in order to prevent major output collapses in times of crisis, as there is room for expansionary monetary policy to improve economic growth provided that inflation is well below its threshold.

There are important avenues for future research. An empirical limitation of dynamic panel threshold models is that these methods require the threshold variable to be assumed strictly exogenous in the model. As suggested by Caner and Hansen (2004) and Kremer et al. (2013), the implementation of dynamic panel threshold models where the threshold

[267] For a discussion on the structuralist view of inflation in Latin America see Baer (1967) and Boianovsky (2012). In addition, it is also our view that inflation mainly affects output growth in Latin America by distorting the allocation of resources and reducing the productivity of capital.

variable and the control regressors are both considered endogenous require a completely different statistical theory and threshold estimation procedures[268]. Despite that our results suggest that the direction of cause primarily runs from inflation to economic growth—as initially suggested by Fischer (1993)—it would be an interesting topic for future research to estimate a dynamic panel threshold model of inflation and economic growth where inflation as threshold variable is considered endogenous.

The economic growth and inflation performance of Latin America has varied substantially in the post-reform period after the economic reforms of the 1990's. Many economies in the region have adopted inflation targeting regimes and other schemes of monetary and fiscal policy to combat inflation alongside with important institutional and market reforms (Edwards, 1995, Lora and Panizza, 2002). The region experienced economic growth with price stability in the years prior to the global financial crisis in 2008. In the light of the economic reforms implemented in the region, it would be worthwhile and interesting to revisit the roots of inflation in Latin America, as well as alternatives inflation stabilization policies and their potential output and welfare costs.

[268] Recent advances on panel threshold models with an endogenous threshold variable have been initiated by Kourtellos et al. (2007) and Wang and Lin (2010). However, these methods do not currently extend to dynamic panels of economic growth where one of control regressors—such as initial income—is considered as a lagged dependent variable and endogenous regressor in the model.

Chapter 5

Conclusions

The economic growth and development process of the Latin American economies has been historically uneven. The persistent differences in per capita income growth, productivity and economic development have remained relatively invariant over the last century (Parente and Prescott, 2005). This stagnation and backwardness relative to the growth and development of the advanced economies is one of the main motivations for our research. Our view is that the observed differences in growth and development in Latin America can be ascribed to differences in economic policy rather than to differences in factor endowments, geographical characteristics and natural resources.

Our research started with an examination of the economic history of Latin America where we propose that economic policies related to exchange rates, capital accumulation and inflation have been persistently important in explaining the economic growth and development performance of the region. In that order, this thesis examines exchange rates and productivity; capital, economic growth and relative income differences; inflation threshold and economic growth in thirty-two Latin American economies over a period of fifty years from 1960 to 2010. In what follow we briefly discuss the main contributions of our research.

Chapter 2 examines the growth effects of real exchange rate variations, currency misalignments and nominal exchange rate regimes on productivity growth in Latin America. The main original contributions presented in this chapter are as follow. We show that real exchange rate depreciations have a negative and statistically significant effect on productivity growth in Latin America. In other words, we document significant evidence indicating a contractionary effect of real exchange rate depreciations on productivity. Our findings also indicate that real exchange rate volatility inhibit productivity growth in the region. In addition, we find significant evidence that currency misalignments, in particular currency undervaluations, have a detrimental effect on productivity, although the effect is found to be statistically insignificant across different specifications. Furthermore, we also find that nominal exchange rate regimes does not have systematic effects on productivity variations. However, flexible exchange rate arrangements with a tendency towards currency depreciations are found to correlate insignificantly with lower productivity.

Several theoretical and empirical implications emerge from our contributions in this chapter. The dependency of the Latin American economies to imported capital and foreign technologies is suggested to be an important channel through which the contractionary effects of real exchange rate depreciations may operate. By potentially increasing the relative prices of imported capital with embodied technologies, real exchange rate depreciations may limit the adoption and accumulation of imported physical capital, thereby limiting the technological change embodied in capital accumulation, and consequently inhibiting productivity and output growth[269]. In that order, our evidence bring support to the technological disparities hypothesis of the Prebisch-Singer theory (Prebisch, 1950, Singer, 1950, Prebisch, 1959). By limiting capital accumulation with embodied technologies, persistent real exchange rate depreciations may lead to technological disparities with the corresponding negative consequences for growth and development in Latin America.

[269] A comparable argument is proposed by Krugman and Taylor (1978) and Agénor (1991) where currency devaluations—by increasing the costs of imports—may have a contractionary effect on output growth. On the embodiment hypothesis, Hercowitz (1998) present evidence indicating that technological change is mostly embodied in capital accumulation.

Our results presented in this chapter also suggests that currency misalignments have contractionary but insignificant effect on productivity growth. This finding is also novel for the Latin American economies. Conventionally, currency undervaluations are being regarded as conducive for export-led growth, particularly in developing countries (Bhalla, 2008, Gala, 2008, Razmi et al., 2012). However, once we account for the dependency of these economies to imported capital and foreign technologies, the growth effects of currency undervaluations are suggested to be limited and insignificant. In that order, through their potential negative effects on productivity, our findings bring support to the literature which ascribes important welfare costs and distortionary effects of currency misalignments on economic growth (Edwards, 1989, Cottani et al., 1990, Krugman, 1994, Pick and Vollrath, 1994). Overall, our results indicate that exchange rate stability around its equilibrium value is conducive for productivity growth.

We find evidence on the neutrality of nominal exchange rate regimes in explaining productivity variations. Nevertheless, our evidence suggests that flexible exchange rate regimes with a tendency towards currency depreciations do correlate insignificantly with lower productivity growth. For this reason, as in Husain et al. (2005) and Aghion et al. (2009), we advocate to the view that the developing economies of Latin America will benefit more from fixed to intermediate exchange rate arrangements that maintain the stability of the exchange rate, in particular if flexible exchange rate regimes implies excessive currency volatility and depreciations.

The economic policy advice that emerges from our findings in Chapter 2 is as follow. First, we are not advocating to the re-establishment of fixed exchange rate arrangements, and neither to government nor central bank intervention in the foreign exchange rate markets to control the real and nominal exchange rates. Substantial evidence in the literature do suggests that such behaviours have occasionally led to macroeconomic imbalances, particularly in Latin America (Nazmi, 1997, Frenkel and Rapetti, 2011). Second, what we suggest is that excessive floating with a persistent trend towards currency depreciations should worry policy makers in the region. Third, economic policy should aim to preserve the equilibrium exchange rates determined by market forces, and prevent currency misalignments. We call for stable exchange rates, and the stability of foreign exchange rate markets as conducive to productivity, economic growth and development.

The process of capital accumulation has also been a central issue in the study of economic growth and development in Latin America. Chapter 3 examines the growth effects of domestic and imported capital on economic growth and relative income differences in the Latin American economies. The main original contributions of this chapter are as follow. Our results show that countries are able to grow faster by acquiring capital imports. Capital imports are suggested to be an important channel of technology diffusion between the developing economies of Latin America and the rest of the world. We find significant evidence indicating that productivity growth is highly correlated with the acquisition of capital imports in these economies.

The benefits of acquiring capital imports appears to be larger in low income countries. Our evidence suggests that countries that were relatively poorer during the 1970's were able to grow faster by acquiring machinery imports. However, once these economies became relatively richer, the evidence suggests that these countries experienced a slowdown in growth rates since these did not invest enough in the development and accumulation of domestic capital. Insufficient investments in domestic equipment and non-equipment capital have been a major factor explaining the slow growth performance of the Latin American economies.

The results presented in this chapter also indicates that these economies may experience a faster growth and reduce faster their relative income differences by investing relatively more in domestic equipment and non-equipment capital. The observed disparities in the international levels of per capita income in Latin America—relative to the United States—can be ascribed to insufficient investment in domestic capital accumulation. The growth effects of capital accumulation are suggested to be as important as those of total factor productivity growth in explaining the economic growth and development performance of the region.

Various theoretical and empirical implications are derived from our contributions in Chapter 3. Our findings suggest that international trade of capital is an important channel of technology diffusion. In that order, using our novel disaggregated macroeconomic dataset that distinguishes between domestic and imported capital, we documented substantial evidence indicating that productivity growth in the region is highly correlated with the importation of machinery equipment capital. Consequently, we ascribe to the view that technological change is mostly embodied in capital accumulation (Hercowitz, 1998). In addition, we suggest that ascribing economic growth and development primarily to exogenous technological change does not offer a meaningful economic policy advice (Parente and Prescott, 2005). We view the process of economic growth and development as endogenous, that is, influenced by economic policies and institutions as proposed by North (1989, 1991), Romer (1994), Lee (1995) and Acemoglu et al. (2001).

The results presented in Chapter 3 generalize and extend those of De Long and Summers (1991, 1993), Lee (1995) and Mazumdar (2001) with three important differences. First, we focus exclusively in the case of the Latin America economies, and examine the growth effects of domestic and imported capital in the context of the Prebisch-Singer theory of economic development. In that order, our findings show that despite the economies of the region grow faster by acquiring capital imports, relying exclusively in the importation of foreign capital and technology is not sufficient to reduce faster their relative income differences with respect to the United States as industrial leader.

Second, we find that domestic equipment and non-equipment capital has also been a major driver of output and relative income growth in Latin America. This is a novel finding that differs from that of Mazumdar (2001) who suggests that the growth effects of domestic capital may actually be insignificant in developing countries. Third, we reaffirm the predictions of the Prebisch-Singer theory in relation to the technological disparities hypothesis (Prebisch, 1950, Singer, 1950, Prebisch, 1959). We document a general slowdown in economic growth rates and relative income levels in the region since 1970, as the Latin American countries have not invested enough neither in capital imports nor in the development and accumulation of domestic capital[270].

The economic policy advice that emerge from our findings in Chapter 3 is as follow. First, the governments of the region should promote the deregulation of the international trade of capital, particularly the reduction of domestic taxes, quotas and restrictions to the importation of physical capital,

[270] As of 2010, the vast majority of these economies remained on average at a quarter of the United States income level.

in particular that of machinery and transport equipment. Second, the quality of institutions should be improved in order to enhance the security of property rights and maintain the rule of law, thereby creating an institutional environment more conducive to domestic innovation and research in new technologies. Third, more resources should be devoted to the development of human capital, in particular to facilitate the secondary and university education of the lower income groups. Fourth, fiscal and monetary policies should aim to maintain macroeconomic stability, and consequently to promote the efficient allocation of resources and capital. Fifth, private monopolies should be dismounted and anti-trust laws should be enforced to promote competitive markets. Finally, research grants and tax credits should be given to innovative firms that seek to develop new production techniques and methods to reduce production cost and increase productivity via the accumulation of domestic capital.

The evolution of inflation has also been a central issue in the growth and development process of the Latin American economies. Conventionally, inflation has been viewed as harmful for economic growth at all inflation levels, particularly in Latin America (Wallis, 1960, De Gregorio, 1992a, b, Temple, 2000). However, an important branch of the existing literature often disagrees with the previous statement, and suggests the existence of a nonlinear relationship between inflation and economic growth (Fischer, 1993, Sarel, 1996, Burdekin et al., 2004, Drukker et al., 2005, Kremer et al., 2013). In that order, the less developed countries could attain a higher growth by allowing low to moderate inflation rates. However, no studies have been conducted before to examine nonlinearities and threshold effects in the inflation-growth nexus in the Latin American economies, and we address this important gap in the existing literature in the fourth chapter.

Chapter 4 examines inflation threshold and economic growth in Latin America. The main contributions of this chapter are as follow. We show substantial evidence indicating a nonlinear relation between inflation and economic growth in Latin America, as the growth effects of inflation vary across different inflation rates. Our results show the existence of a statistically significant inflation threshold located approximately at a 14% inflation rate. Low to moderate inflation rates below the inflation threshold are found to be conducive to economic growth. However, additional inflation higher than the threshold is found to have significant detrimental effects on output growth.

The evidence presented in this chapter also suggests that countries that have experienced a history of persistent high inflation may have a higher inflation threshold than countries with a history of price stability. In addition, unlike previous existing studies, we are the first to examine the role of fiscal policy in the determination of inflation thresholds in Latin America. Overall, we find significant evidence in favour of nonlinearities and threshold effects in the inflation-growth nexus despite accounting for fiscal policy in the region. Moreover, surprisingly, our findings indicate that the money supply is not a major determinant of nonlinearities and threshold effects in the inflation-growth nexus.

The theoretical and empirical implications that emerge from our contributions in Chapter 4 are as follow. Our findings show the existence of a nonlinear relationship between inflation and output growth as initially suggested by De Gregorio (1992a). However, the novelty of our results are that, to the best of our knowledge, we are the first to document the existence of a statistically significant inflation threshold in the Latin American economies. In that order, since low to moderate inflation rates lower than the inflation threshold correlates significantly with higher growth, our findings imply that the output cost of disinflations at low to moderate inflation rates can be substantial in Latin America, as suggested by Hofstetter (2008).

Once controlling for different time periods in the inflation-growth nexus, our evidence indicates that the detrimental effects of high inflation are lower in the region since the 1990's. This finding is consistent with the view that the output costs of inflation were gradually reduced by the economic reforms implemented in many of the Latin American economies since the late 1980's. These reforms were relatively successful in addressing many of the structural socioeconomic rigidities that were deemed to be the primary causes of the high inflation observed in Latin America (Edwards, 1995, Easterly et al., 1997, Lora and Panizza, 2002).

Surprisingly, we find little evidence indicating that fiscal policy and the money supply have significant effects in the determination of inflation threshold. However, including the measures for fiscal and monetary policy in the estimations do tend to lower the estimate for the growth effects of inflation on economic activity, but does not significantly change the location of the inflation threshold. This finding implies that countercyclical economic policies may be important in reducing the output costs of inflation in the economy.

The main economic policy advice that emerge from our contributions in Chapter 4 is to maintain price stability, but not at all costs. An inflation threshold of 14% offers enough margin for economic policy to be expansionary and allow economic growth to coexist with low to moderate inflation rates lower than the inflation threshold. The structural reforms undertaken by many of the Latin American economies since the late 1980's and during the 1990's have been relatively successful in addressing many of the primary causes of inflation, as well as decreasing its output costs. In that order, Central Banks in the region may exceed temporarily their inflation targets in order to prevent major output collapses in times of macroeconomic distress and crisis. Our results imply that fiscal and monetary policy can be expansionary provided that inflation is well below its threshold value.

Several avenues for future research emerge from our contributions in this thesis. It would be promising to re-examine conventional models of endogenous growth while taking into account the contractionary effect of currency depreciations on productivity operating through a production process that crucially depends on imported capital and foreign technologies. In addition, it would be interesting to develop new classifications for nominal exchange rate regimes that takes into consideration the evolution of the real exchange rate.

Future research should also engage in growth accounting exercises using disaggregated national account data for the Latin American economies in order to re-examine the role of total factor productivity growth and domestic capital accumulation while taking into account the embodiment controversy discussed by Hercowitz (1998). In addition, it would be interesting to re-examine the role of human capital in the growth and development process of these economies, as it appears that the benefits of secondary school education have been exhausted in the region. Following Barro and Lee (2010), new measures for human capital should be developed, and a promising one could be the proportion of the population with a university degree.

The economic growth and inflation performance of Latin America has varied substantially in the post-reform period. Future research should revisit the roots of inflation in Latin America, as well as alternatives inflation stabilization policies, and their potential output and welfare costs. In addition, it would be promising to re-examine traditional models of economic growth while taking into consideration a nonlinear relationship between inflation and output growth. The role of inflation targeting in the growth and development process of the Latin American economies should also be re-examined, particularly when the inflation target is lower than the inflation threshold, as the maintenance of the inflation targeting regime can have substantial output costs.

Future research should also examine the role of inflation targeting regimes in the determination of the inflation thresholds, as the location of the threshold could time-vary with the implementation of inflation targeting in the Latin American economies. Another promising avenue for future research would be to consider the threshold level of accelerating inflation (that is, the change in inflation) as a switch variable, rather than the level of inflation itself. Such a study may shed light on how quickly accelerating inflation may deteriorate economic activity[271].

In the light of our contributions, it would also be promising that future research re-examines the role of export-led growth on economic development in Latin America. Economic policies oriented towards export-led growth and the reliance on imported capital and foreign technologies have not resulted in the expected growth and development in the region. It has been our view that growth should be driven by internal markets and by productivity improvements proceeding from domestic sources. Additional innovation and investments in domestic capital and new technologies has been found vital for Latin America to achieve a sustainable economic growth and development that is conducive to the reduction of relative income differences and the convergence towards the advanced economies living standards.

[271] A pioneering work in this area is the one proposed by Espinoza et al. (2010) where they examine the speed of transition at which additional inflation after the threshold deteriorates output growth. Their results show that inflation exceeding the threshold swiftly turn out to be detrimental to economic growth.

Appendix A

Methodologies and definitions

A.1 List of countries

List of countries

North and Central America					
BLZ	Belize	HND	Honduras		
CRI	Costa Rica	MEX	Mexico		
SLV	El Salvador	NIC	Nicaragua		
GUA	Guatemala	PAN	Panama		
Caribbean					
ATG	Antigua and Barbuda	DMA	Dominica	SKN	Saint Kitts and Nevis
BAH	Bahamas	DOM	Dominican Republic	SLU	Saint Lucia
BRB	Barbados	HTI	Haiti	SVG	Saint Vincent and the Grenadines
GRD	Grenada	JAM	Jamaica	TAT	Trinidad and Tobago
South America					
ARG	Argentina	COL	Colombia	PER	Peru
BOL	Bolivia	ECU	Ecuador	SUR	Suriname
BRA	Brazil	GUY	Guyana	URU	Uruguay
CHL	Chile	PAR	Paraguay	VEN	Venezuela

Notes: List of countries in Latin America and the Caribbean based on the classification of the International Monetary Fund (IMF).

A.2 Economic development classification

The acronyms for the Latin American countries follow those of the International Organization on Standardization (ISO/3166-1, 2006) alpha-3 classification. The development classification of these economies follows the guidelines provided by FTSE (2012), the International Monetary Fund (2012a), Standard & Poor's (2012), J.P. Morgan (1999) and the methodologies proposed by Husain et al. (2005) and Levy-Yeyati et al. (2010).

This broad classification is not strictly based on income, market structure or development indicators. The classification reflects the views of different international organizations as well as the author's criteria.

Latin America

Emerging Market Economies		Developing Countries	
ARG	Argentina	ATG	Antigua and Barbuda
BRA	Brazil	BAH	The Bahamas
CHL	Chile	BRB	Barbados
COL	Colombia	BLZ	Belize
MEX	Mexico	BOL	Bolivia
VEN	Venezuela	CRI	Costa Rica
		DMA	Dominica
		DOM	Dominican Republic
		ECU	Ecuador
		SLV	El Salvador
		GRD	Grenada
		GUA	Guatemala
		GUY	Guyana
		HTI	Haiti
		HND	Honduras
		JAM	Jamaica
		NIC	Nicaragua
		PAN	Panama
		PAR	Paraguay
		PER	Peru
		SKN	St. Kitts and Nevis
		SLU	St. Lucia
		SVG	St. Vincent and the Grenadines
		SUR	Suriname
		TAT	Trinidad and Tobago
		URU	Uruguay

A.3 System GMM estimation for the exchange rates and productivity growth model

Our baseline productivity growth equation is the following output per worker equation:

$$y_{l,t} - y_{l,t-1} = \lambda y_{l,t-1} + \delta r_{l,t} + \beta \Omega'_{l,t} + \tau_t + c_{l,t} + \upsilon_{l,t} \tag{A.3.1}$$

where $y_{l,t}$ denotes output per worker; $y_{l,t-1}$ is the initial output per worker level and $\lambda = (\theta - 1)$; $r_{l,t}$ is a measure of different specifications for real exchange rates, misalignments and exchange rate regimes; δ is the exchange rate parameter coefficient[272]; $\Omega_{l,t}$ is column vector of control variables where β is the column vector of control parameters; τ_t are the time period specific effects; $c_{l,t}$ is a measure of the country specific effect or time invariant unobserved heterogeneity; and $\nu_{l,t}$ denotes the classical error term or idiosyncratic shock. The number of countries are $l \in [1, \ldots, 32]$ Latin America economies, and the time set is $\tau \in [1, \ldots, 6]$ for the five-year averages over the period from 1980 to 2009[273].

The first difference transformation of Eq. (A.3.1) removes the countries time invariant fixed effects. While reducing dynamic panel bias, this operation may prompt an endogenous interaction between the first differences of the covariates and the error component:

$$\Delta y_{l,t} - \Delta y_{l,t-1} = \lambda \Delta y_{l,t-1} + \delta \Delta r_{l,t} + \beta \Delta \Omega'_{l,t} + \Delta \tau_t + \Delta \nu_{l,t}$$

Expanding terms in the previous equation (recall that $\lambda = \theta - 1$)

$$\begin{aligned}(y_{l,t} - y_{l,t-1}) - (y_{l,t-1} - y_{l,t-2}) = {} & (\theta - 1)(y_{l,t-1} - y_{l,t-2}) \\ & + \delta(r_{l,t} - r_{l,t-1}) + \beta \Delta \Omega'_{l,t} \\ & + (\tau_t - \tau_{t-1}) + (\nu_{l,t} - \nu_{l,t-1})\end{aligned}$$

---

[272] Since the hypothesis being tested is that currency depreciations leads to a lower productivity growth when the real exchange rate is defined as national currency per foreign currency units (meaning a rise in the index denotes currency depreciations) this parameter is expected to be $\delta < 0$.

[273] See the data methodologies in Appendix A.6 for additional details on the variables definitions and sources.

The main standard assumptions and initial conditions of the *Arellano-Bover/Blundell-Bond* first difference estimator for Eq. (A.3.1) are as follow[274]:

$$E[\nu_{l,t}] = 0 \ for \ l \in [1, \dots, 32] \ and \ t = 2, \dots, 6 \tag{A.3.2}$$

$$E[c_l] = 0 \ for \ l \in [1, \dots, 32] \ and \ t = 2, \dots, 6 \tag{A.3.3}$$

$$E[\nu_{l,t} c_l] = 0 \ for \ l \in [1, \dots, 32] \ and \ t = 2, \dots, 6 \tag{A.3.4}$$

Serial uncorrelation of the idiosyncratic shock:

$$E[\nu_{l,t}\nu_{l,a}] = 0 \ for \ l \in [1, \dots, 32] \ and \ a \neq t \tag{A.3.5}$$

The initial condition that $y_{l,1}$ is predetermined (Ahn and Schmidt, 1995)

$$E[y_{l,1}\nu_{l,t}] = 0 \ for \ l \in [1, \dots, 32] \ and \ t = 2, \dots, 6 \tag{A.3.6}$$

Throughout the model, the explanatory variables are assumed to be endogenous, that is the real exchange rate and the vector of controls correlate with past and current realizations of the error term, mainly:

$$E[r_{l,t}\nu_{l,a}] = 0 \ for \ l \in [1, \dots, 32] \ and \ t = 2, \dots, 6 \ and \ a \leq t$$

$$E[\Omega_{l,t}\nu_{l,a}] = 0 \ for \ l \in [1, \dots, 32] \ and \ t = 2, \dots, 6 \ and \ a \leq t$$

Since the first differences of the covariates may correlate with the first differences of the idiosyncratic shock these may not be suitable instruments for the estimation of this equation. However, given previous assumptions, second and further lagged levels of the dependent variables and the endogenous regressors can be shown to be orthogonal to the error component. These results leads to the following moment condition for the first difference GMM estimator (Arellano and Bond, 1991):

$$E[y_{l,t-a}(\nu_{l,t} - \nu_{l,t-1}] = 0 \ for \ t = 3, \dots, 6 \ and \ a \geq 2 \tag{A.3.7}$$

---

[274] For a detailed discussion on the assumptions, initial conditions validity and proofs, see Arellano and Bond (1991), Ahn and Schmidt (1995), Arellano and Bover (1995) and Blundell and Bond (1998).

$$E[r_{l,t-a}(\nu_{l,t} - \nu_{l,t-1}] = 0 \ for \ t = 3, \dots ,6 \ and \ a \geq 2 \tag{A.3.8}$$

$$E[\Omega_{l,t-a}(\nu_{l,t} - \nu_{l,t-1}] = 0 \ for \ t = 3, \dots ,6 \ and \ a \geq 2 \tag{A.3.9}$$

Based on these moment conditions second and further lagged levels of the covariates and the dependent variable are valid instruments for the first difference equation. These instruments are proven to be valid subject to the idiosyncratic shock non serial correlation assumption[275].

For highly persistent series ($|\theta| \approx 1$) such as output per worker growth, using lagged levels as instruments for the first difference equation may convey low levels of information about variables future changes thus making necessary the use of additional instruments that captures more information and improve efficiency. Such additional instruments can be specified by using lagged first differences as instruments for an additional equation estimated in levels (Arellano and Bover, 1995).

The linear system GMM estimator has superior finite sample properties and is more efficient in the context of small time periods and large individuals than the standard first difference GMM estimator[276]. The system estimator uses first differences of the covariates as instruments for an equation in levels in addition to the traditional lagged levels used as instruments for the equation in first differences.

The use of lagged first differences as instruments for an equation in levels can dramatically improve efficiency over the first difference linear GMM estimator proven that these lagged first differences are uncorrelated with the country unobserved time invariant fixed effects. The system estimator, in addition to assumptions (A.3.3) through (A.3.6), requires the assumption (Blundell and Bond, 1998):

$$E[\Delta y_{l,2} c_l] = 0 \ for \ l \in [1, \dots ,32] \tag{A.3.10}$$

[275] The time period specific effects (time dummies) are assumed to be strictly exogenous in these types of models. Under the strict exogeneity assumption all leads and lags of the variable become valid instruments. These are exogenous and therefore do not correlate with the error component therefore remaining valid instruments.

[276] See Arellano and Bover (1995) and Blundell and Bond (1998).

The validity of the moment conditions involves also the assumption of constant means of the covariates. This latter assumption is strengthen by the inclusion of period specific effects within the system, which allows for common growth among the variables. In that order, Bond et al. (2001) and Blundell and Bond (2000) suggests that the assumption of mean stationarity is not indispensable in growth models since it is plausible to assume that first difference of the variables are already uncorrelated with the country fixed effects, that is covariates variations (growth) do not depend on countries time-invariant fixed effects[277]. This implies than in addition to assumption (A.3.10) it is also assumed that:

$$E[(y_{l,t} - y_{l,t-1})c_l] = 0 \ for\ l \in [1, \dots ,32]\ and\ t = 2, \dots ,6 \tag{A.3.11}$$

$$E[(r_{l,t} - r_{l,t-1})c_l] = 0 \ for\ l \in [1, \dots ,32]\ and\ t = 2, \dots ,6 \tag{A.3.12}$$

$$E[\Delta\Omega_{l,t}c_l] = 0 \ for\ l \in [1, \dots ,32]\ and\ t = 2, \dots ,6 \tag{A.3.13}$$

Therefore, provided that first differences of the covariates are uncorrelated with the countries fixed effects and that the error component is serially uncorrelated, we can use first differences of the variables as instruments for an equation in levels, in addition to variables levels as instruments for an equation in first differences (Arellano and Bond, 1991, Arellano and Bover, 1995, Blundell and Bond, 1998).

Given assumptions A.3.2 to A.3.6 and A.3.10 to A.3.13, the following linear moment conditions outline the available instruments that can be used for an equation in levels:

$$E[(y_{l,t-1} - y_{l,t-2})(c_l + \nu_{l,t})] = 0 \ for\ l \in [1, \dots ,32]\ and\ t = 3, \dots ,6 \tag{A.3.14}$$

$$E[(r_{l,t-1} - r_{l,t-2})(c_l + \nu_{l,t})] = 0 \ for\ l \in [1, \dots ,32]\ and\ t = 3, \dots ,6 \tag{A.3.15}$$

$$E[(\Delta\Omega_{l,t-1})(c_l + \nu_{l,t})] = 0 \ for\ l \in [1, \dots ,32]\ and\ t = 3, \dots ,6 \tag{A.3.16}$$

[277] The levels of the variables are assumed to be correlated with the fixed effects. However, variables first differences are assumed uncorrelated with the fixed effects.

As an example, consider that in period four these moment conditions will outline the respective instruments for the levels equation given by:

$$y_{l,4} - y_{l,3} = \lambda y_{l,3} + \delta r_{l,4} + \beta \Omega'_{l,4} + \tau_4 + c_{l,4} + \upsilon_{l,4}$$

These moment conditions will suggest as available instruments: $\Delta y_{l,3}, \Delta r_{l,3}, \Delta \Omega'{}_{l,3}$, $\Delta \tau_3$, and these remain orthogonal to the period four error component ($\nu_{l,4}$).

Hence there is a system of equations, an equation in first differences in addition to an equation in levels, for which the instruments outlined by the moment conditions A.3.7 to A.3.9 and A.3.14 to A.3.16 can be used to estimate the linear system GMM estimator[278].

[278] Recall that this class of estimator is superior to the first difference GMM estimator, and suitable for the estimation of growth models since instruments convey valid information in the context of high persistent series, which are those that characterizes growth regressions (Bond et al., 2001).

A.4 The real exchange rate

Following standard conventions of the literature, let us define the Latin American countries price ratio with respect to the United States as:

$$\frac{P_{u,t}}{P_{l,t}}$$

where P by assumption refers to the consumer price index of a common basket of goods and services, the subscript $l \in [1, \dots, 32]$ refers to each Latin American country (LAC), the subscript u represents the United States of America (USA), and t follows for the time dimension.

Extending the concept of the law of one price to all the goods and services represented in the consumer price index, the absolute purchasing power parity (PPP) between each country with respect to the United States is defined as:

$$P_{l,t} = e_{l,t} P_{u,t}$$

where $e_{l,t}$ denotes the nominal (spot) exchange rate of country l at time t. This nominal exchange rate is in national currency per U.S. dollar unless otherwise indicated. The log transformation of the previous equation introduces the notion that in the long run the nominal exchange rate should account for inflation differentials between the domestic economy and the U.S., namely that:

$$\varepsilon_{l,t} = p_{l,t} - p_{u,t}$$

In that order, ε represents the logarithmic transformation of the nominal exchange rate, the lower case p denotes the consumer price index in logarithms, and the subscripts follows the standard conventions defined previously.

The first difference of the above equation denotes the relative purchasing power parity (PPP) between each country and the industrial leader:

$$\varepsilon_{l,t} - \varepsilon_{l,t-1} = (p_{u,t} - p_{u,t-1}) - (p_{l,t} - p_{l,t-1})$$

The real exchange rate is defined as the nominal exchange rate adjusted for price differences in the two country model. The bilateral real exchange rate of each economy with respect to the United States is then the nominal bilateral exchange rate adjusted by prices differentials, namely[279]:

$$R_{l,t} = e_{l,t}\frac{P_{u,t}}{P_{l,t}}$$

Depreciations in the real value of a Latin American currency correspond to a raise in $R_{l,t}$, while appreciations correspond to a fall in $R_{l,t}$. In other words, depreciations in the nominal spot exchange rate (a rise in $e_{l,t}$) will be associated with a real depreciation (a raise in $R_{l,t}$).

[279] See, for example, the works of Obstfeld and Rogoff (1996), Sarno and Taylor (2002), Catão (2007) and Evans (2011).

A.5 Spline function model with multiple knots

The study of the relationship between inflation and economic growth builds on the following dynamic panel cross-country growth model:

$$dlny_{i,t} = \alpha + \beta\Pi_{i,t} + \delta' Z_{i,t} + \mu_t + \eta_i + e_{i,t} \tag{A.5.1}$$

where $y_{i,t}$ denote the real GDP per capita; $\Pi_{i,t}$ denotes an inflation function; $Z_{i,t}$ is a k-vector of control variables; μ_t and η_i are respectively the time and country specific effects; $e_{i,t}$ denotes the country specific term. The panel dimensions are $\eta \in [1,\ldots,32]$ Latin American economies across $t \in [1,\ldots,10]$ five years averages from 1960 to 2010. The subscript i and t denotes respectively the country and time period.

Note that by construction Eq. (A.5.1) assumes constant growth effects of inflation at different inflation rates. In order to distinguish nonlinearities in the model, a more appropriate specification should account for different inflation effects at different inflation thresholds (τ), namely[280]:

$$dlny = \alpha_a + \beta_a\Pi + \delta' Z + \mu + \eta + e \quad if\ \Pi < \tau_1 \tag{A.5.2}$$
$$dlny = \alpha_b + \beta_b\Pi + \delta' Z + \mu + \eta + e \quad if\ \tau_1 \leq \Pi < \tau_2 \tag{A.5.3}$$
$$dlny = \alpha_c + \beta_c\Pi + \delta' Z + \mu + \eta + e \quad if\ \Pi \geq \tau_2 \tag{A.5.4}$$

In that order, for example, the estimation of the subsample a will result in the growth effects of inflation when it is below the threshold level τ_1. In addition, let

$$q_k = \begin{cases} 1\ if\ \Pi \geq \tau_k \\ 0\ if\ \Pi < \tau_k \end{cases}$$

where k is the number of threshold values or knots, that is: $q_1 = 1\ if\ \Pi \geq \tau_1$ and so forth. Therefore, we can combine the previous equations as

$$dlny = \alpha + \beta\Pi + \gamma_1 q_1 + \phi_1 q_1 \Pi + \gamma_2 q_2 + \phi_2 q_2 \Pi + \delta' Z + \mu + \eta + e \tag{A.5.5}$$

[280] Country and time subscripts are omitted from the explanation to simplify the discussion. We mainly focus on the traditional case of two inflation threshold, however these results extent in a similar fashion to additional threshold levels. We follow closely the definition and mechanics of spline regressions provided by Greene (2012).

For this function to be continuous at the knots we impose the following requirements for a piecewise continuous function

$$\alpha + \beta\tau_1 = \alpha + \lambda_1 + (\beta + \phi_1)\tau_1 \tag{A.6.A}$$
$$\alpha + \lambda_1 + (\beta + \phi_1)\tau_2 = \alpha + \lambda_1 + \lambda_2 + (\beta + \phi_1 + \phi_2)\tau_2 \tag{A.6.B}$$

These conditions imply that the slopes of the function are joined at the knots, which results in: $\lambda_1 = -\phi_1\tau_1$and $\lambda_2 = -\phi_2\tau_2$ by collecting terms. Inserting these in (A.5.5) yields

$$dlny = \alpha + \beta\Pi + (-\phi_1\tau_1 q_1) + \phi_1 q_1\Pi + (-\phi_2\tau_2 q_2) + \phi_2 q_2\Pi + \delta' Z + \mu + \eta + e$$

Reorganizing terms

$$dlny = \alpha + \beta\Pi + \phi_1 q_1(\Pi - \tau_1) + \phi_2 q_2(\Pi - \tau_2) + \delta' Z + \mu + \eta + e \tag{A.5.7}$$

To simplify the notation, let us rename some of the coefficients in (A.5.7) as $\beta = \beta_1$, $\phi_1 = \beta_2$ and $\phi_2 = \beta_3$. In addition, let us include the country and time subscripts

$$dlny_{i,t} = \alpha + \beta_1\Pi_{i,t} + \beta_2 q_1(\Pi_{i,t} - \tau_1) + \beta_3 q_2(\Pi_{i,t} - \tau_2) + \delta' Z_{i,t} + \mu_t + \eta_i + e_{i,t}$$

This equation represents a spline function with two thresholds or knots. When the inflation rate is below the threshold level τ_1 the growth effects of inflation are measures by the coefficient β_1. When inflation exceeds the first threshold level but is below the upper threshold τ_2, then the inflation effects are measured by the sum of $\beta_1$and β_2. Finally, when inflation exceeds both thresholds then the growth effects of inflation are the sum of the β's coefficients. These results extend in a similar fashion to the incorporation of additional thresholds knots in the equation.

A.6 Definitions and sources of the variables

Capital imports: Real capital imports divided by real GDP per capita. The real capital imports are calculated as the ratio of machinery imports per capita to total investment PPP per capita at current prices, times the total investment PPP converted GDP per capita at 2005 constant prices. The machinery imports per capita are measured as the machinery imports divided by the total population. The total imports of machinery equipment at current prices proceeds from those reported by the domestic economy from the rest of the world. SITC revision 1: sections 7.1 and 7.2 corresponding to machinery other than electric plus electrical machinery. Source: Author's calculations using the methodology proposed by Lee (1995), and data from the United Nations COMTRADE database.

Capital imports growth: The growth rates of real capital imports calculated by logarithmic differences. Source: Author calculations.

Capital imports in investment: Ratio of machinery imports per capita to total investment PPP per capita at current US$ dollars. Source: Author calculations based on the methodology proposed by Lee (1995).

Crisis (banking): Considered as the number of years in banking crisis (including bank runs and systemic banking crisis) as a proportion of the total number of years within each period. Source: Author calculations using data from Reinhart and Rogoff (2009) and Laeven and Valencia (2010, 2012).

Crisis (currency): A depreciation of the national currency versus the U.S. dollar, or a basket of currencies, higher than 30% per year. The nominal exchange rate is the official exchange rate (LCU per US$, period average) (PA.NUS.FCRF). Defined as the number of years in currency crisis as a proportion of the total number of years within each period. Source: Author calculations using the methodology proposed by Reinhart and Rogoff (2009), and using data proceeding from the World Development Indicators.

Crisis (macroeconomic): Number of years in banking and/or currency crisis as a proportion of the total number of years within each period. Source: Author calculations.

Domestic capital: Real domestic capital divided by real GDP per capita. The real domestic capital is calculated as the total investments PPP converted GDP per capita at 2005 constant prices minus the machinery imports PPP converted GDP per capita at 2005 constant prices. Source: Author's calculations using the methodology proposed by Lee (1995).

Domestic capital growth: Real domestic capital imports growth rates calculated by logarithmic differences. Source: Author calculations.

Domestic credit to private sector: Domestic credit to private sector (% of GDP) (FS.AST.PRVT.GD.ZS). Source: World Development Indicators.

Education: Highest level of educational attainment of the total secondary education as a percentage of the population aged 15 and over. Source: Barro and Lee (2010).

Emerging markets economies: Dummy variable indicating whether the economy can be classified as an emerging market economy or a developing country. Source: Author calculations using the FTSE (2012), International Monetary Fund (2012b), Standard & Poor's (2012) and J.P. Morgan (1999) classifications according to the methodologies proposed by Husain et al. (2005) and Levy-Yeyati et al. (2010).

Exchange rate regime *natural* classification: The coarse taxonomy of the natural classification of modern exchange rate arrangements (Ilzetzki et al., 2008). Source: Author calculations using data from Reinhart and Rogoff (2004) and Ilzetzki et al. (2008).

Exchange rate regime *de facto* classification: The extended 3-way *de facto* exchange rate regime classification. Source: Author calculations using data from Levy-Yeyati and Sturzenegger (2005).

Exchange rate regime *de jure* classification: Exchange rate regime classification according to the International Monetary Fund (IMF). Source: Author calculations using data from Ilzetzki et al. (2008).

External debt: External debt stocks as a percentage of the Gross National Income (GNI) (DT.DOD.DECT.GN.ZS). Source: World Development Indicators.

GDP per capita (real): PPP converted GDP per capita, chain series, at 2005 constant prices (cgdp). Source: Penn World Tables.

GDP per capita growth (real): Real GDP per capita growth rate calculated by logarithmic differences. Source: Author calculations using data from the Penn World Tables.

GDP per capita (initial): Initial value of real GDP per capita at the start of each interval of time. Source: Penn World Tables.

Government consumption: General government final consumption expenditure (% of GDP). (NE.CON.GOVT.ZS). Source: World Development Indicators.

Human capital: Educational attainment as secondary school enrolment (% gross) (SE.SEC.ENRR). Source: World Development Indicators.

Imports of goods and services: Imports of goods and services (% of GDP) (NE.IMP.GNFS.ZS). Source: World Development Indicators.

Income per capita (relative): PPP converted GDP per capita relative to the United States, G-K method, at current prices, [cgdp] (US = 100). Source: Penn World Tables.

Inflation Growth rate of the consumer Price Index (2005 = 100) at the end of the year (line 64…ZF). In Chapter 2 the growth rates are calculated by the logarithm of one plus the annual change in the CPI. Source: Author calculations using data from the World Economic Outlook and International Financial Statistics.

Inflation crisis: An inflation crisis is defined as an annual inflation rate of 20% or more. Defined as the number of years in crisis as a proportion of the number of years within each interval. Source: Author calculations using the methodology proposed by Reinhart and Rogoff (2009), and using data from the World Development Indicators and the International Financial Statistics.

Investment: Total investment as gross capital formation (% of GDP) (NE.GDI.TOTL.ZS). Source: World Development Indicators.

Investment share: Investment share of the PPP Converted GDP Per Capita at 2005 constant prices [rgdpl]. Source: Penn World Tables.

Institutions: Number of institutions within government with veto over policy changes. The veto points refers to the extent of institutionalized constraints on the decision making powers of the chief executives, whether individuals or collectivities. Veto Points, Political Constrain Index (POLCON-III) dataset. Source: Henisz (2002, 2010, 2012).

Lack of price stability: Logarithm of one plus the annual percentage change in the Consumer Price Index (2005 = 100) at the end of the year. Source: Author calculations based on Levy-Yeyati et al. (2010) methodology.

Land size: Land area (sq. km) (AG.LND.TOTL.K2). Source: World Development Indicators.

Nominal exchange rate index: Official exchange rate (LCU per US$, period average). (PA.NUS.FCRF), Index (2005=100). Source: Author calculations using data from the World Development Indicators.

Output per worker: PPP converted GDP per worker, chain series, at 2005 constant prices (rgdpwok). Source: Penn World Tables.

Output per worker (initial): Initial value of the PPP converted GDP per worker, chain series, at 2005 constant prices (rgdpwok) at the beginning of each period. Source: Penn World Tables.

Population growth: Population growth rates calculated by logarithmic differences. Source: Author calculations using data from the Penn World Tables.

Productivity growth: Defined as the growth rate of the output per worker, calculated by logarithmic differences. Source: Author calculations using data from the Penn World Tables based on the methodology proposed by Aghion et al. (2009).

Real bilateral exchange rate index: Nominal exchange rate (national currency per U.S. Dollar) times the ratio of the United States consumer price index to the domestic economy consumer price index. Index (2005=100). Source: Author calculations using data from the World Development Indicators, World Economic Outlook and International Financial Statistics.

Real bilateral exchange rate index, purchasing power parity (PPI): Nominal exchange rate (national currency per U.S. Dollar) times the ratio of the United States producer price index to the domestic economy consumer price index. Index (2005=100). Source: Author calculations using data from the World Development Indicators, World Economic Outlook and International Financial Statistics.

Real bilateral exchange rate index, Penn World Tables (PWT): Nominal exchange rate (xrat) divided by the purchasing power parity (ppp). Calculated as an index (2005=100). Source: Author calculations using data from the Penn World Tables.

Real bilateral exchange rate index, wholesale price index (WPI): Nominal exchange rate (national currency per U.S. Dollar) times the ratio of the United States wholesale price index to the domestic economy wholesale price index. Index (2005=100). Note: When countries did not report wholesale price indexes, consumer price indexes were used instead. Source: Author calculations using data from the World Development Indicators, World Economic Outlook and International Financial Statistics.

Real bilateral exchange rate volatility: Standard deviation of the annual real bilateral exchange rate index growth rates within each interval of time. Source: Author calculations based on the methodology proposed by Aghion et al. (2009).

Real effective exchange rate index: Real effective exchange rate index based on consumer prices (line RECZF REER based on REL.CP). Index (2005=100). Source: International Financial Statistics.

Real effective exchange rate volatility: Standard deviations of the annual real effective exchange rate index growth rates within each interval of time. Source: Author calculations using data from the real effective exchange rate index.

Savings: Gross domestic savings as a percentage of GDP. (NY.GDS.TOTL.ZS). Source: World Development Indicators.

Tariff rate: Applied tariff rate, simple mean on all products (%) (TM.TAX.MRCH.SM.AR.ZS). Source: World Development Indicators.

Trade openness: Real trade openness at 2005 constant prices. (openk). Source: Penn World Tables.

Terms of trade: Exports as a capacity to import. Data in local currency units (NY.EXP.CAPM.KN). Source: Author calculations based on the methodology proposed by Levy-Yeyati et al. (2010), and using data from the World Development Indicators.

Terms of trade growth: Growth rate of the terms of trade calculated by logarithmic differences. Source: Author's calculations.

Terms of trade volatility: Standard deviation of the annual terms of trade growth rates. Source: Author calculations.

Undervaluation (index): Deviation of the real exchange rate index from its equilibrium value. The real exchange rate values are adjusted by Balassa-Samuelson effects. This is a proxy for real exchange rate misalignment. Source: Author estimations based on Rodrik (2008) methodology, and using data from the Penn World Tables.

Undervaluation (series): Deviation of the real bilateral exchange rate from its stochastic trend. We control for stochastic trends using the Hodrick–Prescott filter with a smoothing parameter of λ=6.25. Source: Authors estimations based on the methodology proposed by Goldfajn and Valdes (1999) adjusted by Ravn and Uhlig (2002) frequency rule, and using data from the World Development Indicators, World Economic Outlook and International Financial Statistics.

Appendix B

Supplementary tables

Table B.1
Real exchange rate effects on productivity growth in Latin America
Robustness: alternative specifications
Time Horizon: 1980-2009, five-year averages
System generalized method of moments estimation

	(1)	(2)	(3)	(4)	(5)
Real exchange rate indexes					
Bilateral consumer price index (CPI)	-0.207**				
	(0.0978)				
Bilateral wholesale price index (WPI)		-0.236**			
		(0.114)			
Bilateral producer price index (PPI)			-0.240*		
			(0.118)		
Penn World Table index (PWT)				-0.371*	
				(0.203)	
Bilateral effective index					0.226*
					(0.116)
Initial output per worker	-1.642	-1.025	-1.014	-0.392	-0.121
	(2.209)	(1.698)	(1.699)	(3.463)	(1.901)
Savings	0.144	0.153	0.151	0.979	0.0165
	(0.108)	(0.0928)	(0.0924)	(2.503)	(0.211)
Institutions	14.08*	9.601***	9.699***	9.406	
	(6.936)	(1.800)	(1.859)	(8.110)	
External debt	-0.777	-0.833	-0.832		
	(1.405)	(1.228)	(1.222)		
Financial development	0.839	0.516	0.571		
	(1.601)	(1.223)	(1.213)		
Terms of trade				-0.0595	
				(0.151)	
Investment					11.12
					(7.390)
Trade openness	3.387	2.747**	2.750**	0.440	-3.887
	(2.422)	(1.117)	(1.101)	(1.789)	(4.221)
Government consumption	-4.175	-3.068	-3.135	-1.625	2.692
	(2.796)	(2.214)	(2.273)	(3.772)	(2.984)
Inflation	-1.515	-0.757	-0.845	-3.137	-4.773
	(1.435)	(1.683)	(1.681)	(4.883)	(3.144)
Banking and currency crisis	-1.724	-2.884	-2.770	1.249	-2.348
	(2.716)	(2.853)	(2.773)	(4.672)	(3.305)
Constant	9.130	4.448	4.386	1.609	-24.77
	(26.26)	(14.86)	(14.84)	(29.01)	(33.68)
Specification tests					
i) *F*-statistic	0.00	0.00	0.00	0.00	0.00
ii) Serial Correlation					
Arellano and Bond AR(2)	0.57	0.77	0.76	0.11	0.16
iii) Hansen *J* statistic for instruments validity	0.55	0.61	0.63	0.38	0.72
iv) Difference-in-Hansen Statistic					
Lagged growth instruments	1.00	0.59	0.57	0.58	1.00
All system GMM instruments	0.55	0.79	0.81	0.38	0.72
Observations	142	142	142	120	112
Number of groups	26	26	26	23	20
Instrument count	27	27	27	23	22

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the real exchange rate index (growth) measure currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). This table reports the t-test instead of the z-test, and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: the control regressors are assumed endogenous. Initial output per worker was assumed predetermined, using second lags in regression (4) and (5). The endogenous variables use second lags for the difference equation and first lags for the levels equation. Predetermined variables, in addition, are instrumented with first lags for the difference equation and contemporaneous lagged first differences as instruments for the level equations. All the estimations include time period specific effects. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

Table B.2
Real exchange rate effects on productivity growth in Latin America
Robustness: controls set specifications and instrument count
Time horizon: 1980-2009, five-year averages
System generalized method of moments estimation

	(1)	(2)	(3)
Real bilateral exchange rate	-0.155*	-0.183*	-0.220**
	(0.0852)	(0.102)	(0.0863)
Initial output per worker	-1.139	-1.063	-0.886
	(2.298)	(1.438)	(1.122)
Institutions	2.537	2.619	
	(3.316)	(5.650)	
Financial development: domestic credit to private sector	0.542	0.294	
	(0.778)	(1.397)	
Terms of trade growth	0.128**		
	(0.0596)		
Terms of trade volatility		-0.0251	
		(0.0565)	
Education			2.742
			(2.820)
Investment			0.928
			(3.307)
Financial development: emerging markets dummy			0.670
			(1.495)
Trade openness	0.428	0.651	1.221
	(1.048)	(1.170)	(1.542)
Government consumption	-1.483	-2.303	-1.999
	(1.686)	(1.633)	(1.794)
Inflation	-1.241	-1.436	-1.773
	(1.398)	(0.989)	(1.539)
Banking and currency crisis	-0.440	-0.539	0.443
	(4.493)	(3.321)	(2.523)
Constant	10.46	12.01	-3.495
	(19.74)	(15.56)	(13.79)
Specification tests			
i) F- statistic	0.00	0.00	0.00
ii) Serial Correlation			
Arellano and Bond AR(2)	0.71	0.80	0.38
iii) Hansen J statistic for instruments validity	0.43	0.43	0.34
iv) Difference-in-Hansen Statistic			
Lagged growth instruments	0.96	0.57	0.24
All system GMM instruments	0.43	0.43	0.34
Observations	128	128	138
Number of groups	23	23	24
Instrument count	23	23	24

Notes: The sample correspond to an unbalanced panel of thirty-two Latin American economies from 1980 to 2009. The dependent variable is productivity growth. The growth rates are in percentage changes (that is, multiplied by 100). Increases in the real exchange rate index (growth) measure currency depreciations. System Generalized Method of Moments (System GMM) estimation following Roodman (2009a) programming for the two-step Arellano-Bover/Blundell-Bond estimator with Windmeijer (2005) finite sample corrections. Small sample adjustments with collapsed instruments have been performed in all the estimations (Roodman, 2009b). This table reports the t-test instead of the z-test, and the F test instead of the Wald $\chi 2$ test for the general model. GMM instrumentation: the endogenous regressors are assumed endogenous, except for the terms of trade which is assumed exogenous. The initial output per worker was assumed predetermined, using second lags in regression (1) and (3). Endogenous variables are instrumented with the second lags for the difference equation and first lags for the levels equation. Predetermined variables are instrumented with first lags for the difference equations and contemporaneous lagged first differences as instruments for the level equations. All the estimations include time period specific effects. Standard errors are given in parenthesis. Specifications tests reports the p-values.
***Significant at 1%, **Significant at 5%, *Significant at 10%

Table B.3

Inflation thresholds and economic growth in Latin America

Pairwise correlation coefficients

	Real GDP per capita growth	Inflation	Initial income	Investment	Population growth	Terms of trade growth	Terms of trade volatility
Real GDP per capita growth (%)	1.0000						
Inflation function (%)	-0.2910*	1.0000					
Initial income (US$ at 2005 constant prices)	-0.1424*	-0.0810	1.0000				
Investment share (% of GDP)	0.2883*	-0.1051	0.3288*	1.0000			
Population growth (%)	-0.1578*	0.0179	-0.2554*	-0.2331*	1.0000		
Terms of trade growth (%)	0.5136*	-0.1080	-0.0160	0.1426	0.0384	1.0000	
Terms of trade volatility	-0.1489	0.2330*	-0.1275	-0.1421	0.0408	-0.0879	1.0000
Trade openness (% of GDP)	0.1852*	-0.4770*	0.1419*	0.3557*	-0.3180*	-0.0664	-0.1695*
Trade openness volatility	-0.1343*	0.1555*	0.0105	-0.0119	-0.0458	0.1036	0.1464
Domestic credit to private sector (% of GDP)	0.0641	-0.3075*	0.4057*	0.2847*	-0.3625*	-0.0636	-0.2241*
Banking and currency crisis (ratio from 0 to 1)	-0.3483*	0.7024*	-0.0086	-0.1145	0.1236*	-0.0958	0.1722*
Money supply growth (%)	-0.0070	-0.1879*	-0.0021	-0.0555	0.0082	-0.1049	-0.1039
Government cash surplus/deficit (% to GDP)	0.2770*	-0.2289*	-0.0760	0.0166	0.0682	0.2569*	-0.0018
Government consumption (% to GDP)	-0.0018	-0.1549*	0.1202	0.2318*	-0.4830*	-0.0931	-0.0320

Notes: The sample is an unbalanced panel of thirty Latin American economies from 1960 to 2010. Nicaragua and Trinidad and Tobago are excluded from the sample due to extreme values. The unit of observations is in five-year averages. *Correlation coefficient significant at 5% or less.

Table B.3 *(continued)*

Inflation thresholds and economic growth in Latin America

Pairwise correlation coefficients

	Trade openness	Trade openness volatility	Domestic credit to private sector	Banking and currency crisis	Money supply growth	Government cash surplus/deficit	Government consumption
Trade openness (% of GDP)	1.0000						
Trade openness volatility	0.0354	1.0000					
Domestic credit to private sector (% of GDP)	0.3822*	-0.0867	1.0000				
Banking and currency crisis (ratio from 0 to 1)	-0.4584*	0.0906	-0.2001*	1.0000			
Money supply growth (%)	0.0594	-0.2379*	0.0565	-0.1984*	1.0000		
Government cash surplus/deficit (% to GDP)	-0.0990	0.0276	-0.0505	-0.0337	0.1608*	1.0000	
Government consumption (% to GDP)	0.4141*	0.1997*	0.3681*	-0.1743*	0.0470	-0.1748*	1.0000

Notes: The sample is an unbalanced panel of thirty Latin American economies from 1960 to 2010. Nicaragua and Trinidad and Tobago are excluded from the sample due to extreme values. The unit of observations is in five-year averages. *Correlation coefficient significant at 5% or less.

Table B.4
Causality tests in the inflation-growth nexus in Latin America

Null Hyphotesis	Obs	F-Statistic	Prob.
Inflation does not Granger cause growth	177	6.55364	0.0003
Growth does not Granger cause inflation		3.37306	0.0198

Notes: Pairwise Granger causality test for panel data. The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The unit of observations is in five-year averages. Due to data availability we use the common coefficients method. The choice of lags (3) is data based, however results extend to the case where the test is conducted using only first lags a well as other lags selections. We use the inflation function or semi-log transformation of the inflation rate in order to lessen the influence of outliers and incorporate the dynamics of negative inflation rates in the test. Economic growth is defined as the percentage growth rate of the PPP converted GDP per capita (chain series) at 2005 US$ dollars constant prices.

Table B.5
Inflation growth nexus in a cross-section of Latin American countries

Dep. var.: real GDP per capita growth Period: 1970-2010	(1)	(2)	(3)
Inflation function	-0.0163	-0.0364	
	(0.0924)	(0.0959)	
Marginal growth effects of inflation			
Inflation ($\hat{\beta}_1$): below 14%:			0.166
			(0.586)
Inflation ($\hat{\beta}_2$): above 14%:			-0.224
			(0.585)
Initial income	-0.836**	-0.875**	-0.857**
	(0.318)	(0.311)	(0.309)
Investment share	1.391**	1.304**	1.293**
	(0.511)	(0.527)	(0.514)
Population growth	-0.566**	-0.464*	-0.439
	(0.217)	(0.232)	(0.266)
Terms of trade growth	0.159***	0.140***	0.143***
	(0.0289)	(0.0385)	(0.0418)
Terms of trade volatility	-0.0574***	-0.0541**	-0.0535**
	(0.0134)	(0.0185)	(0.0188)
Trade openness	0.336	0.152	0.205
	(0.400)	(0.365)	(0.409)
Trade openness volatility	-1.203	-0.983	-0.979
	(1.069)	(0.999)	(1.018)
Regional dummies		0.0198	0.0151
		(0.288)	(0.295)
Domestic credit to private sector		0.531*	0.643
		(0.290)	(0.417)
Constant	4.487	3.852	2.636
	(3.421)	(3.516)	(4.237)
Adjusted R-squared	0.545	0.524	0.491
F-statistic *(p-value)*	0.00	0.00	0.00
Number of countries	24	24	24

Notes: Estimates (1) and (2) are obtained via the estimation of Eq. (4.1) through the ordinary least squares estimator (OLS). Estimate (3) is obtained via the estimation of Eq. (4.2) through OLS. The sample is a cross section of Latin American economies from 1970 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The unit of observations is in averages from 1970 to 2010. The threshold variable is the inflation function. The overall growth effect of inflation is given by the inflation function coefficient in the standard growth regresssion (1) and (2). In the spline function regression (3), the overall growth effect of inflation is given by the β coefficient when inflation is below the threshold (14%); however, when inflation exceeds the specified threshold, the overall growth effect of inflation is given by the sum of the β's coefficient. Statistics are heteroskedasticity consistent. Robust standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

Table B.6
Panel threshold estimation
Robustness: additional explanatory variables and outliers sensitivity

	(1)	(2)	(3)
Threshold estimates	19.70%	22.4%	15.48%
95% confidence interval	[19.70-21.36]	[17.98-51.04]	[14.07-18.82]
Joint R-squared:	0.55	0.67	0.61
Observations	110	110	50
Number of countries	11	11	5

Notes: Panel threshold estimation (Eq. 4.6). The sample is a balanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in five-year averages. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). Each regime contain at least 5% of the observations (Hansen, 1999). The control regressors in estimation (1) are investment, population growth, terms of trade growth and volatility, trade openness growth and volatility. Estimation (2) adds to the set of control regressors the initial income in 1960, domestic credit to private sector, and a measure of banking and currency crisis. Finally, in estimation (3) we re-estimate (1) only considering those countries which experienced inflation rates less than 40% during the sample period.

Table B.7
Tests for threshold effects in the inflation-growth nexus in Latin America
Robustness: additional explanatory variables, outliers sensitivity and time period

	1960-2010			1980-2010
	(1)	(2)	(3)	(4)
LM-test for no threshold	24.240	19.942	15.771	16.785
Bootstrap p-value:	0.0004	0.029	0.023	0.011
Number of bootstrap replications	5000	5000	5000	5000
Trimming percentage:	0.15	0.15	0.15	0.15
Observations	110	110	50	102
Number of countries	11	11	5	17

Notes: Tests for threshold effects in a panel data setting (Eq. 4.6). The sample is a balanced panel of Latin American economies. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in five-year averages. The heteroskedasticity-consistent Lagrange multiplier test for a threshold is that of Hansen (1996, 2000). The null hyphotesis is no threshold effects. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). Each regime contains at least 5% of the observations (Hansen, 1999). The set of control regressors in estimation (1) includes investment, population growth, terms of trade growth and volatility, trade openness growth and volatility. In (2) we add the initial income in the 1960, domestic credit to private sector, banking and currency crisis. For (3) we re-estimate (1) only considering those countries which experienced inflation rates less than 40% during the sample period. Finally, in (4) we increase the number of countries by reducing the time horizon and the number of explanatory regressors to initial income in 1960, investment, population growth, terms of trade growth and volatility.

Table B.8
Inflation thresholds and economic growth in Latin America
Robustness: additional explanatory variables, outlier's sensitivity, instrument count and time period

	(1)	(2)	(3)	(4)	(5)	(6)
Threshold estimates and confidence interval						
Threshold ($\hat{\tau}$)	14.07%	14.07%	14.74%	14.07%	14.07%	14.07%
Confidence interval (90%)	[13.92-15.08]	[13.92-15.08]	[2.81-22.54]	[13.92-15.48]	[13.92-15.48]	[4.44-28.13]
Regime dependent regressors						
$\widehat{\beta_1}$	0.645***	0.490**	0.735**	0.494***	0.568**	0.611***
	(0.197)	(0.243)	(0.303)	(0.251)	(0.246)	(0.229)
$\widehat{\delta_1}$	-0.793	-0.488	-0.575	-0.509	-0.557	-0.445
	(1.014)	(1.087)	(1.123)	(1.089)	(1.126)	(1.012)
$\widehat{\beta_2}$	-0.456**	-0.536**	0.006	-0.522**	-0.539**	-0.048
	(0.237)	(0.260)	(0.214)	(0.259)	(0.260)	(0.277)
Regime independent regressors						
Initial income	-2.626***	-1.404	-0.369	-1.160	-0.847	-1.363
	(0.932)	(1.438)	(1.837)	(1.553)	(1.659)	(1.320)
Investment	2.324***	2.199**	2.459***	2.117**	2.074**	1.496**
	(0.927)	(0.952)	(0.925)	(0.935)	(1.009)	(0.875)
Population growth	-1.457***	-1.334***	-0.647	-1.257***	-1.402***	-1.176***
	(0.262)	(0.374)	(0.610)	(0.402)	(0.333)	(0.352)
Terms of trade growth	0.220***	0.229***	0.278***	0.234***	0.239***	0.227***
	(0.035)	(0.040)	(0.039)	(0.042)	(0.042)	(0.036)
Terms of trade volatility	-0.004	0.004	-0.026	0.007	-0.006	-0.006
	(0.023)	(0.026)	(0.042)	(0.027)	(0.026)	(0.026)
Trade openness	-0.908	-1.470**	1.289	-1.489**	-1.655**	-0.903
	(0.609)	(0.708)	(1.257)	(0.740)	(0.783)	(0.670)
Trade openness volatility	2.826	3.496	2.507	3.408		
	(3.836)	(4.513)	(5.519)	(4.565)		
Money supply growth				1.880		
				(3.165)		
Domestic credit to private sector					-0.785	
					(0.692)	
Banking and currency crisis						-2.728***
						(0.834)
Sample period	1960-2010	1960-2010	1980-2010	1960-2010	1960-2010	1960-2010
Observations	110	110	102	110	110	110
Instrument count	7	1	5	1	1	1
Number of countries	11	11	17	11	11	11

Notes: Dynamic panel threshold estimation (Eq. 4.7). The sample is a balanced panel of Latin American economies. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The threshold variable is the inflation function. The unit of observations is in five-year averages. The initial income is considered as the endogenous regressor and its lagged levels are used as instruments. Each regime contains at least 5% of the observations (Hansen, 1999). Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

Table B.9
Inflation thresholds and fiscal policy in Latin America
Robustness: threshold test sensitivity to alternative fiscal policy measures and time period

	Cash surplus/deficit (% GDP)		Government consumption (% GDP)	
	1960-2010	1980-2010	1960-2010	1980-2010
LM-test for no inflation threshold	18.014	15.405	24.926	13.608
Bootstrap p-value:	0.0152	0.079	0.001	0.326
Number of bootstrap replications	5000	5000	5000	5000
Trimming percentage:	0.15	0.15	0.15	0.15
Observations	50	60	100	96
Number of countries	5	10	10	16

Notes: Test for threshold effects in a panel data setting (Eq. 4.6) extended with the fiscal variables. The sample is a balanced panel of Latin American economies. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observations is in five-year averages. The heteroskedasticity-consistent Lagrange multiplier test for a threshold is that of Hansen (1996, 2000). The null hyphotesis is no threshold effects. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). Each regime contains at least 5% of the observations (Hansen, 1999). The control regressors includes in addition to the respective fiscal measure the investment, population growth, terms of trade growth and volatility, trade openness growth and volatility.

Table B.10
Inflation thresholds and fiscal policy in Latin America
Robustness: cross-sectional threshold test sensitivity to alternative fiscal policy measures

	Cash surplus/deficit (% GDP)	Government consumption (% GDP)
Threshold estimates and confidence intervals		
Threshold estimate	14.41%	15.90%
95% confidence interval	[14.41-14.41]	[14.41-15.90]
Joint R-Squared:	0.89	0.80
Test for threshold effects		
Threshold estimate (logs)	2.880	2.766
LM-test for no threshold	7.995	13.723
Bootstrap p-value:	0.884	0.065
Number of bootstrap replications	5000	5000
Trimming percentage:	0.15	0.15
Number of countries	22	24

Notes: Testing for threshold effects in Eq. (4.5) extended with the fiscal measures. The sample is a cross section of Latin American economies. The dependent variable is real GDP per capita growth. The threshold variable is the inflation function. The unit of observation is in long run averages from 1970 to 2010. The heteroskedasticity-consistent Lagrange multiplier test for a threshold is that of Hansen (1996, 2000). The null hyphotesis is no threshold effects. The White method is implemented to correct for heteroskedasticity (Hansen, 1996). Each regime contains at least 5% of the observations (Hansen, 1999). The standard set of control regressors includes in addition to the respective fiscal measure the investment, population growth, terms of trade growth and volatility, trade openness growth and volatility.

Table B.11
Inflation-growth nexus and fiscal policy in Latin America
Robustness: econometric methodology, outlier's sensitivity and additional explanatory variables

Dep. var.: real GDP per capita growth Period: 1960-2010	All inflation rates					
	(1)	(2)	(3)	(4)	(5)	(6)
Inflation function	-0.369**	-0.394***	-0.390***	-0.438**	-0.367**	-0.367**
	(0.168)	(0.133)	(0.129)	(0.186)	(0.148)	(0.147)
Initial income	-4.821*	-4.084***	-4.054***	-3.875	-3.282**	-3.281*
	(2.487)	(1.064)	(1.155)	(2.720)	(1.612)	(1.681)
Investment share	2.358**	2.259***	2.244***	2.601**	2.536***	2.533**
	(0.907)	(0.757)	(0.784)	(1.076)	(0.949)	(0.981)
Population growth	-0.739*	-0.578**	-0.571**	-0.726*	-0.638	-0.636
	(0.408)	(0.238)	(0.223)	(0.426)	(0.440)	(0.432)
Terms of trade growth	0.134***	0.157***	0.158***	0.140***	0.174***	0.174***
	(0.0292)	(0.0394)	(0.0420)	(0.0403)	(0.0442)	(0.0454)
Terms of trade volatility	-0.00753	-0.0326	-0.0322	-0.0138	-0.0556*	-0.0555*
	(0.0334)	(0.0262)	(0.0265)	(0.0363)	(0.0310)	(0.0313)
Trade openness	-0.209	0.339	0.342	-0.127	0.416	0.418
	(1.046)	(0.835)	(0.835)	(0.976)	(0.869)	(0.875)
Trade openness volatility	2.152	-0.383	-0.397	2.498	1.142	1.140
	(4.068)	(4.449)	(4.470)	(5.064)	(5.002)	(5.010)
Government cash surplus/deficit to GDP	-1.549			-4.342	-1.349*	
	(3.745)			(4.342)	(0.736)	
Government consumption to GDP		-1.205**	-1.211**			-1.351*
		(0.555)	(0.549)			(0.742)
Money supply growth			0.430			0.0486
			(2.487)			(2.413)
Constant	35.50*	31.20***	30.96***			
	(17.42)	(8.892)	(9.457)			
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.65	0.61	0.61	0.57	0.57	0.57
F-statistic *(p-value)*	0.00	0.00	0.00	0.00	0.00	0.00
Instrumental variables specification tests:						
Kleibergen-Paap *rk* LM test for underidentification				0.006	0.003	0.000
Kleibergen-Paap *rk* Wald F statistic for weak identification				24.82	38.99	38.42
Hansen *J* test of overidentifying restrictions				0.59	0.19	0.19
Endogeneity test				0.16	0.17	0.17
Observations	118	162	162	105	138	138
Number of countries	19	21	21	17	20	20

Notes: This table reports estimates of Eq. (4.1) through the within-groups estimator [(1),(2),(3),(7),(8) and (9)] and the two-stage least squares fixed effects estimator [(4),(5),(6),(10)(11) and (12)]. The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The unit of observations is in five-year averages. The initial income is considered as the endogenous regressor in the instrumental variables estimations. Lagged levels of initial income up to the second lag are used as instruments. The instrumental variables specification tests are those of Kleibergen and Paap (2006), Stock and Yogo (2005), Hansen (1982) and Baum et al. (2003, 2007). These tests report the p-values, except for the Kleibergen-Paap rk Wald F statistic whose critical value according to Stock and Yogo (2005) approximate 19.93 for the 10% maximal IV size. Statistics are heteroskedasticity and autocorrelation consistent (HAC). Clustered-robust standard errors are reported in the within-groups estimations. The two-stage least squares estimates report robust standard errors obtained through the Barlett kernel with Newey-West (1994) fixed bandwidth rule. Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

Table B.11 *(contibued)*
Inflation-growth nexus and fiscal policy in Latin America
Robustness: econometric methodology, outlier's sensitivity and additional explanatory variables

Dep. var.: real GDP per capita growth Period: 1960-2010	Inflation rates less than 40%					
	(7)	(8)	(9)	(10)	(11)	(12)
Inflation function	-0.235	-0.285	-0.272	-0.365	-0.136	-0.130
	(0.370)	(0.289)	(0.295)	(0.513)	(0.351)	(0.358)
Initial income	-3.297	-3.118**	-3.041**	-1.372	-2.476	-2.439
	(2.571)	(1.217)	(1.191)	(2.822)	(2.002)	(1.966)
Investment share	1.929*	1.858**	1.832**	2.215*	2.515**	2.501*
	(1.071)	(0.787)	(0.790)	(1.315)	(1.251)	(1.280)
Population growth	-0.634	-0.454*	-0.431	-0.682*	-0.771	-0.764
	(0.367)	(0.253)	(0.255)	(0.390)	(0.495)	(0.504)
Terms of trade growth	0.163***	0.165***	0.169***	0.181***	0.186***	0.187***
	(0.0263)	(0.0299)	(0.0313)	(0.0382)	(0.0380)	(0.0374)
Terms of trade volatility	0.0149	-0.0147	-0.0142	0.0134	-0.0288	-0.0285
	(0.0347)	(0.0228)	(0.0228)	(0.0373)	(0.0321)	(0.0323)
Trade openness	0.166	0.208	0.224	0.293	-0.0734	-0.0655
	(1.020)	(0.861)	(0.869)	(1.088)	(0.991)	(1.012)
Trade openness volatility	-0.606	-2.400	-2.311	-0.445	-1.937	-1.899
	(4.532)	(4.338)	(4.390)	(5.619)	(5.645)	(5.772)
Government cash surplus/deficit to GDP	2.081			0.268		
	(9.852)			(12.54)		
Government consumption to GDP		-1.220*	-1.253*		-0.914	-0.933
		(0.604)	(0.615)		(0.900)	(0.977)
Money supply growth			1.442			0.362
			(2.119)			(2.912)
Constant	22.43	24.18**	23.54**			
	(17.03)	(10.59)	(10.36)			
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.59	0.57	0.57	0.46	0.51	0.50
F-statistic *(p-value)*	0.00	0.00	0.00	0.00	0.00	0.00
Instrumental variables specification tests:						
Kleibergen-Paap *rk* LM test for underidentification				0.004	0.01	0.00
Kleibergen-Paap *rk* Wald F statistic for weak identification				22.83	37.54	29.86
Hansen *J* test of overidentifying restrictions				0.64	0.20	0.19
Endogeneity test				0.07	0.16	0.14
Observations	103	135	135	90	112	112
Number of countries	19	21	21	17	20	20

Notes: This table reports estimates of Eq. (4.1) through the within-groups estimator [(1),(2),(3),(7),(8) and (9)] and the two-stage least squares fixed effects estimator [(4),(5),(6),(10)(11) and (12)]. The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The unit of observations is in five-year averages. The initial income is considered as the endogenous regressor in the instrumental variables estimations. Lagged levels of initial income up to the second lag are used as instruments. The instrumental variables specification tests are those of Kleibergen and Paap (2006), Stock and Yogo (2005), Hansen (1982) and Baum et al. (2003, 2007). These tests report the p-values, except for the Kleibergen-Paap rk Wald F statistic whose critical value according to Stock and Yogo (2005) approximate 19.93 for the 10% maximal IV size. Statistics are heteroskedasticity and autocorrelation consistent (HAC). Clustered-robust standard errors are reported in the within-groups estimations. The two-stage least squares estimates report robust standard errors obtained through the Barlett kernel with Newey-West (1994) fixed bandwidth rule. Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

Table B.12
Inflation thresholds and fiscal policy in Latin America
Robustness: econometric methodology, outlier's sensitivity and additional explanatory variables

Dep. var.: real GDP per capita growth Period: 1960-2010	All inflation rates					
	(1)	(2)	(3)	(4)	(5)	(6)
Growth effects of inflation:						
Inflation ($\hat{\beta}_1$) : below 14%:	-0.353	-0.0706	-0.0692	-0.501	0.0124	0.0103
	(0.299)	(0.254)	(0.253)	(0.484)	(0.237)	(0.238)
Inflation ($\hat{\beta}_2$): above 14%:	-0.0227	-0.507	-0.506	0.115	-0.566*	-0.569*
	(0.379)	(0.375)	(0.377)	(0.602)	(0.335)	(0.335)
Control regressors						
Initial income	-4.818*	-4.144***	-4.128***	-3.753	-2.720*	-2.753*
	(2.487)	(1.066)	(1.179)	(2.532)	(1.394)	(1.464)
Investment share	2.354**	1.943**	1.936**	2.524**	2.243**	2.266**
	(0.896)	(0.758)	(0.785)	(1.006)	(0.877)	(0.921)
Population growth	-0.744*	-0.618**	-0.614***	-0.814*	-0.792**	-0.799**
	(0.399)	(0.224)	(0.210)	(0.435)	(0.330)	(0.326)
Terms of trade growth	0.134***	0.157***	0.157***	0.142***	0.174***	0.173***
	(0.0285)	(0.0381)	(0.0407)	(0.0388)	(0.0431)	(0.0441)
Terms of trade volatility	-0.00750	-0.0354	-0.0352	-0.00663	-0.0486	-0.0491
	(0.0335)	(0.0255)	(0.0259)	(0.0330)	(0.0316)	(0.0318)
Trade openness	-0.205	0.406	0.408	-0.249	0.161	0.156
	(1.054)	(0.845)	(0.846)	(0.910)	(0.683)	(0.684)
Trade openness volatility	2.174	0.0101	0.00121	2.259	0.779	0.785
	(4.111)	(4.397)	(4.400)	(4.653)	(4.713)	(4.714)
Government cash surplus/deficit to GDP	-1.649			-2.270		
	(3.914)			(4.766)		
Government consumption to GDP		-1.314**	-1.316**		-1.155*	-1.150*
		(0.551)	(0.546)		(0.631)	(0.634)
Money supply growth			0.230			-0.357
			(2.619)			(2.473)
Constant	35.47*	32.37***	32.24***			
	(17.38)	(8.640)	(9.405)			
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.64	0.62	0.62	0.56	0.56	0.56
F-statistic *(p-value)*	0.00	0.00	0.00	0.00	0.00	0.00
Instrumental variables specification tests:						
Kleibergen-Paap *rk* LM test for underidentification				0.00	0.00	0.00
Kleibergen-Paap *rk* Wald F statistic for weak identification				53.30	102.68	97.66
Endogeneity test				0.27	0.20	0.20
Observations	118	162	162	111	150	150
Number of countries	19	21	21	17	20	20

Notes: This table reports estimates of Eq. (4.2) through the within-groups estimator [(1),(2),(3),(7),(8) and (9)] and the two-stage least squares fixed effects estimator [(4),(5),(6),(10),(11) and (12)]. The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The threshold variable is the inflation function. The unit of observations is in five-year averages. The overall growth effect of inflation is given by the sum of the β's coefficients when inflation exceeds the threshold (14%). Otherwise, below the threshold, the overall effect of inflation is represented by the β_1 coefficient. The initial income is considered as the endogenous regressor in the instrumental variables estimations. Lagged levels of initial income up to the first lag are used as instruments. The instrumental variables specification tests are those of Kleibergen and Paap (2006), Stock and Yogo (2005) and Baum et al. (2003, 2007). These tests report the p-values, except for the Kleibergen-Paap rk Wald F statistic whose critical value according to Stock and Yogo (2005) approximate 16.38 for the 10% maximal IV size. The Hansen (1982) *J*-test of overidentifying restrictions is not reported as the equations are exactly identified. Statistics are heteroskedasticity and autocorrelation consistent (HAC). Clustered-robust standard errors are reported in the within-groups estimations. The two-stage least squares estimates report robust standard errors obtained through the Barlett kernel with Newey-West (1994) fixed bandwidth rule. Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

Table B.12 *(continued)*
Inflation thresholds and fiscal policy in Latin America
Robustness: econometric methodology, outlier's sensitivity and additional explanatory variables

Dep. var.: real GDP per capita growth Period: 1960-2010	Inflation rates less than 40%					
	(7)	(8)	(9)	(10)	(11)	(12)
Growth effects of inflation:						
Inflation ($\hat{\beta}_1$) : below 14%:	-0.0885	0.00049	0.00564	-0.143	0.0717	0.0695
	(0.284)	(0.262)	(0.266)	(0.491)	(0.273)	(0.273)
Inflation ($\hat{\beta}_2$): above 14%:	-0.763	-1.942*	-1.920*	-0.757	-1.655*	-1.670*
	(0.830)	(0.954)	(0.967)	(1.146)	(0.901)	(0.935)
Control regressors						
Initial income	-3.181	-2.762**	-2.715**	-1.544	-1.776	-1.821
	(2.578)	(1.216)	(1.213)	(2.696)	(1.736)	(1.706)
Investment share	1.879*	1.711**	1.696*	2.044	2.231**	2.250**
	(1.077)	(0.819)	(0.828)	(1.278)	(1.104)	(1.131)
Population growth	-0.706*	-0.603**	-0.586**	-0.803**	-0.831**	-0.840**
	(0.360)	(0.212)	(0.221)	(0.382)	(0.323)	(0.341)
Terms of trade growth	0.165***	0.172***	0.175***	0.183***	0.192***	0.191***
	(0.0250)	(0.0290)	(0.0307)	(0.0364)	(0.0374)	(0.0366)
Terms of trade volatility	0.0193	-0.00744	-0.00721	0.0191	-0.0152	-0.0154
	(0.0353)	(0.0237)	(0.0238)	(0.0364)	(0.0312)	(0.0314)
Trade openness	0.0813	-0.0541	-0.0407	0.0351	-0.405	-0.415
	(1.033)	(0.793)	(0.805)	(1.000)	(0.751)	(0.765)
Trade openness volatility	-1.088	-3.711	-3.637	-1.097	-3.762	-3.810
	(4.446)	(4.503)	(4.562)	(5.358)	(5.319)	(5.466)
Government cash surplus/deficit to GDP	3.113			2.127		
	(10.33)			(11.93)		
Government consumption to GDP		-1.177*	-1.200*		-0.961	-0.951
		(0.659)	(0.670)		(0.764)	(0.803)
Money supply growth			0.947			-0.455
			(2.140)			(2.737)
Constant	22.05	22.80**	22.40**			
	(16.93)	(10.41)	(10.38)			
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country specific effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.59	0.59	0.59	0.46	0.51	0.51
F-statistic *(p-value)*	0.00	0.00	0.00	0.00	0.00	0.00
Instrumental variables specification tests:						
Kleibergen-Paap *rk* LM test for underidentification				0.00	0.00	0.00
Kleibergen-Paap *rk* Wald F statistic for weak identification				44.10	94.42	76.27
Endogeneity test				0.13	0.31	0.31
Observations	103	135	135	96	123	123
Number of countries	19	21	21	17	20	20

Notes: This table reports estimates of Eq. (4.2) through the within-groups estimator [(1),(2),(3),(7),(8) and (9)] and the two-stage least squares fixed effects estimator [(4),(5),(6),(10),(11) and (12)]. The sample is an unbalanced panel of Latin American economies from 1960 to 2010. The dependent variable is real GDP per capita growth. The growth rates are in percentage terms. The threshold variable is the inflation function. The unit of observations is in five-year averages. The overall growth effect of inflation is given by the sum of the β's coefficients when inflation exceeds the threshold (14%). Otherwise, below the threshold, the overall effect of inflation is represented by the β_1 coefficient. The initial income is considered as the endogenous regressor in the instrumental variables estimations. Lagged levels of initial income up to the first lag are used as instruments. The instrumental variables specification tests are those of Kleibergen and Paap (2006), Stock and Yogo (2005) and Baum et al. (2003, 2007). These tests report the p-values, except for the Kleibergen-Paap rk Wald F statistic whose critical value according to Stock and Yogo (2005) approximate 16.38 for the 10% maximal IV size. The Hansen (1982) *J*-test of overidentifying restrictions is not reported as the equations are exactly identified. Statistics are heteroskedasticity and autocorrelation consistent (HAC). Clustered-robust standard errors are reported in the within-groups estimations. The two-stage least squares estimates report robust standard errors obtained through the Barlett kernel with Newey-West (1994) fixed bandwidth rule. Standard errors are given in parenthesis.
***Significant at 1%, **Significant at 5%, *Significant at 10%.

References

Acemoglu, D. (2009). *Introduction to Modern Economic Growth*. Princeton University Press.

Acemoglu, D., Johnson, S. and Robinson, J. (2001). The Colonial Origins of Comparative Development: An Empirical Investigation. *American Economic Review,* 91(5), 1369-1401.

Acemoglu, D., Johnson, S., Robinson, J. and Thaicharoen, Y. (2003). Institutional causes, macroeconomic symptoms: volatility, crises and growth. *Journal of Monetary Economics,* 50(1), 49-123.

Agénor, P. R. (1991). Output, devaluation and the real exchange rate in developing countries. *Weltwirtschaftliches Archiv,* 127(1), 18-41.

Aghion, P., Bacchetta, P., Rancière, R. and Rogoff, K. (2009). Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics,* 56(4), 494-513.

Ahn, S. C. and Schmidt, P. (1995). Efficient estimation of models for dynamic panel data. *Journal of Econometrics,* 68(1), 5-27.

Alonso-Borrego, C. and Arellano, M. (1999). Symmetrically normalized instrumental-variable estimation using panel data. *Journal of Business & Economic Statistics,* 17(1), 36-49.

Anderson, T. and Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of Econometrics,* 18(1), 47-82.

Anderson, T. W. (1951). Estimating Linear Restrictions on Regression Coefficients for Multivariate Normal Distributions. *The Annals of Mathematical Statistics,* 22(3), 327-351.

Arellano, M. (1987). Computing Robust Standard Errors for Within-groups Estimators. *Oxford Bulletin of Economics and Statistics,* 49(4), 431-434.

Arellano, M. and Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies,* 58(2), 277-297.

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

Arida, P. (1986). Macroeconomic issues for Latin America. *Journal of Development Economics,* 22(1), 171-208.

Arndt, H. W. (1985). The origins of structuralism. *World Development,* 13(2), 151-159.

Astorga, P. (2010). A century of economic growth in Latin America. *Journal of Development Economics,* 92(2), 232-243.

Baer, W. (1962). The Economics of Prebisch and ECLA. *Economic Development and Cultural Change,* 10(2), 169-182.

Baer, W. (1967). The Inflation Controversy in Latin America: A Survey. *Latin American Research Review,* 2(2), 3-25.

Baer, W. (1972). Import Substitution and Industrialization in Latin America: Experiences and Interpretations. *Latin American Research Review,* 7(1), 95-122.

Baer, W. (1984). Industrialization in Latin America: Successes and Failures. *The Journal of Economic Education,* 15(2), 124-135.

Baer, W. and Maloney, W. (1997). Neoliberalism and income distribution in Latin America. *World Development,* 25(3), 311-327.

Balassa, B. (1964). The Purchasing-Power Parity Doctrine: A Reappraisal. *Journal of Political Economy,* 72(6), 584-596.

Barro, R. (1991). Economic Growth in a Cross Section of Countries. *Quarterly Journal of Economics,* 106(2), 407-443.

Barro, R. (1996). Inflation and growth. *Review-Federal Reserve Bank of Saint Louis,* 78, 153-169.

Barro, R. (2001). Human Capital and Growth. *The American Economic Review,* 91(2), 12-17.

Barro, R. and Lee, J.-W. (2010). A New Data Set of Educational Attainment in the World, 1950–2010. *National Bureau of Economic Research Working Paper Series,* No. 15902.

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

Barro, R. and Sala-i-Martin, X. (2004). *Economic Growth*. McGraw-Hill.

Baum, C., Schaffer, M. and Stillman, S. (2003). Instrumental variables and GMM: Estimation and testing. *Stata Journal,* 3(1), 1-31.

Baum, C., Schaffer, M. and Stillman, S. (2007). Enhanced routines for instrumental variables/GMM estimation and testing. *Stata Journal,* 7(4), 465-506.

Baxter, M. and Stockman, A. (1989). Business cycles and the exchange-rate regime: Some international evidence. *Journal of Monetary Economics,* 23(3), 377-400.

Becker, G. S. (1962). Investment in Human Capital: A Theoretical Analysis. *Journal of Political Economy,* 70(5), 9-49.

Bhalla, S. (2008). Economic development and the role of currency undervaluation. *Cato Journal,* 28, 313.

Bick, A. (2010). Threshold effects of inflation on economic growth in developing countries. *Economics Letters,* 108(2), 126-129.

Bittencourt, M. (2012). Inflation and economic growth in Latin America: Some panel time-series evidence. *Economic Modelling,* 29(2), 333-340.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics,* 87(1), 115-143.

Blundell, R. and Bond, S. (2000). GMM Estimation with persistent panel data: an application to production functions. *Econometric Reviews,* 19(3), 321-340.

Boianovsky, M. (2012). Celso Furtado and the structuralist-monetarist debate on economic stabilization in Latin America. *History of Political Economy,* 44(2), 277-330.

Bond, S., Hoeffler, A. and Temple, J. (2001). GMM Estimation of Empirical Growth Models. *University of Oxford Nuffield College Economics Working Papers,* 2001-W21(September).

Bresser-Pereira, L. C. (1993). Economic reforms and economic growth: efficiency and politics in Latin America. In: Bresser-Pereira, L. C., Maravall, J. M. and Przeworski, A. eds. *Economic reforms in new democracies: A social democratic approach*. Cambridge: Cambridge University Press, pp. 15-76.

Bruno, M. and Easterly, W. (1998). Inflation crises and long-run growth. *Journal of Monetary Economics,* 41(1), 3-26.

Bruton, H. (1967). Productivity Growth in Latin America. *The American Economic Review,* 57(5), 1099-1116.

Bullard, J. and Keating, J. W. (1995). The long-run relationship between inflation and output in postwar economies. *Journal of Monetary Economics,* 36(3), 477-496.

Bulmer-Thomas, V. (2003). *The economic history of Latin America since independence*. Second ed. New York: Cambridge University Press.

Burdekin, R. C. K., Denzau, A. T., Keil, M. W., Sitthiyot, T. and Willett, T. D. (2004). When does inflation hurt economic growth? Different nonlinearities for different economies. *Journal of Macroeconomics,* 26(3), 519-532.

Cagan, P. (1956). *The Monetary Dynamics of Hyperinflation. Studies in the Quantity Theory of Money, edited by M. Friedman*. University of Chicago Press.

Calvo, G. and Reinhart, C. (2002). Fear of Floating. *The Quarterly Journal of Economics,* 117(2), 379-408.

Caner, M. and Hansen, B. E. (2004). Instrumental Variable Estimation of a Threshold Model. *Econometric Theory,* 20(5), 813-843.

Cárdenas, M. and Perry, G. (2011). Fiscal Policy in Latin America. In: Ocampo, J. A. and Ros, J. eds. *The Oxford Handbook of Latin American Economics*. New York: Oxford University Press.

Cardoso, E. and Fishlow, A. (1992). Latin American economic development: 1950–1980. *Journal of Latin American Studies,* 24(S1), 197-218.

Caselli, F., Esquivel, G. and Lefort, F. (1996). Reopening the convergence debate: A new look at cross-country growth empirics. *Journal of Economic Growth,* 1(3), 363-389.

Catão, L. (2007). Why Real Exchange Rates? *Finance and Development,* 44(3), 46-47.

Catão, L. and Terrones, M. (2005). Fiscal deficits and inflation. *Journal of Monetary Economics,* 52(3), 529-554.

Chamberlain, G. (1984). Chapter 22 Panel data. In: Zvi, G. and Michael, D. I. eds. *Handbook of Econometrics*. Vol. 2. Elsevier, pp. 1247-1318.

Chan, K. S. (1993). Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model. *The Annals of Statistics,* 21(1), 520-533.

Christoffersen, P. and Doyle, P. (2000). From inflation to growth. *Economics of Transition,* 8(2), 421-451.

Clark, A. E., Frijters, P. and Shields, M. A. (2008). Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles. *Journal of Economic Literature,* 46(1), 95-144.

Clark, T. E. (1997). Cross-Country Evidence on Long-Run Growth and Inflation. *Economic Inquiry,* 35(1), 70-81.

Coatsworth, J. (2005). Structures, endowments, and institutions in the economic history of Latin America. *Latin American Research Review,* 40(3), 126-144.

Coatsworth, J. (2008). Inequality, Institutions and Economic Growth in Latin America. *Journal of Latin American Studies,* 40(03), 545-569.

Cottani, J. A., Cavallo, D. F. and Khan, M. S. (1990). Real Exchange Rate Behavior and Economic Performance in LDCs. *Economic Development and Cultural Change,* 39(1), 61-76.

Couharde, C. and Sallenave, A. (2013). How do currency misalignments' threshold affect economic growth? *Journal of Macroeconomics,* 36(0), 106-120.

Cragg, J. G. and Donald, S. G. (1993). Testing identifiability and specification in instrumental variable models. *Econometric Theory,* 9(02), 222-240.

Crespi, G. and Zuniga, P. (2012). Innovation and Productivity: Evidence from Six Latin American Countries. *World Development,* 40(2), 273-290.

Daude, C. and Fernández-Arias, E. (2010). On the Role of Productivity and Factor Accumulation in Economic Development in Latin America and the Caribbean. *Inter-American Development Bank,* (IDB-WP-155).

De Gregorio, J. (1992a). Economic Growth in Latin America. *Journal of Development Economics,* 39(1), 59-84.

De Gregorio, J. (1992b). The effects of inflation on economic growth: lessons from Latin America. *European Economic Review,* 36(2), 417-425.

De Gregorio, J. (1993). Inflation, taxation, and long-run growth. *Journal of Monetary Economics,* 31(3), 271-298.

De Long, J. B. and Summers, L. H. (1991). Equipment investment and economic growth. *The Quarterly Journal of Economics,* 106(2), 445-502.

De Long, J. B. and Summers, L. H. (1993). How strongly do developing economies benefit from equipment investment? *Journal of Monetary Economics,* 32(3), 395-415.

Denison, E. F. (1964). The Unimportance of the Embodied Question. *The American Economic Review,* 54(2), 90-94.

Di Filippo, A. (2009). Latin American structuralism and economic theory. *Cepal Review.*

Díaz-Alejandro, C. (1963). A Note on the Impact of Devaluation and the Redistributive Effect. *Journal of Political Economy,* 71(6), 577-580.

Donald, S. G. and Maddala, G. S. (1993). Identifying outliers and influential observations in econometric models. In: *Handbook of Statistics*. Vol. 11. Elsevier, pp. 663-701.

Dornbusch, R. and Fischer, S. (1993). Moderate Inflation. *The World Bank Economic Review,* 7(1), 1-44.

Driffill, J., Mizon, G. E. and Ulph, A. (1990). Chapter 19 Costs of inflation. In: Benjamin, M. F. and Frank, H. H. eds. *Handbook of Monetary Economics*. Vol. Volume 2. Elsevier, pp. 1013-1066.

Driscoll, J. C. and Kraay, A. C. (1998). Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. *The Review of Economics and Statistics,* 80(4), 549-560.

Drukker, D., Gomis-Porqueras, P. and Hernandez-Verme, P. (2005). Threshold effects in the relationship between inflation and growth: A new panel-data approach. *Munich Personal RePEc Archive (MPRA),* Paper No. 38225.

Durbin, J. (1954). Errors in Variables. *Revue de l'Institut International de Statistique / Review of the International Statistical Institute,* 22(1/3), 23-32.

Durlauf, S., Johnson, P. and Temple, J. (2005). Chapter 8 Growth Econometrics. In: Philippe, A. and Steven, N. D. eds. *Handbook of Economic Growth*. Vol. 1, Part A. Elsevier, pp. 555-677.

Easterly, W. and Levine, R. (2001). It's Not Factor Accumulation: Stylized Facts and Growth Models. *The World Bank Economic Review,* 15(2), 177-219.

Easterly, W. and Levine, R. (2003). Tropics, germs, and crops: how endowments influence economic development. *Journal of Monetary Economics,* 50(1), 3-39.

Easterly, W., Loayza, N. and Montiel, P. (1997). Has Latin America's post-reform growth been disappointing? *Journal of International Economics,* 43(3–4), 287-311.

Easterly, W. and Rebelo, S. (1993). Fiscal policy and economic growth. *Journal of Monetary Economics,* 32(3), 417-458.

Edwards, S. (1989). Exchange Rate Misalignments in Developing Countries. *The World Bank Research Observer,* 4(1), 3-21.

Edwards, S. (1995). *Crisis and Reform in Latin America: From Despair to Hope*. New York, N.Y.: Oxford University Press.

Eichengreen, B. (2008). *The Real Exchange Rate and Economic Growth*. Washington, DC: Commission on Growth and Development.

Ellis, L. (2001). *Measuring The Real Exchange Rate: Pitfalls And Practicalities*. Research Discussion Paper. Reserve Bank of Australia.

Engen, E. M. and Skinner, J. (1992). Fiscal Policy and Economic Growth. *National Bureau of Economic Research Working Paper Series,* No. 4223.

Engerman, S. L. (2003). Comment on: Tropics, germs and crops: How endowments influence economic development. *Journal of Monetary Economics,* 50(1), 41-47.

Engerman, S. L. and Sokoloff, K. L. (2000). History Lessons: Institutions, Factors Endowments, and Paths of Development in the New World. *The Journal of Economic Perspectives,* 14(3), 217-232.

Engerman, S. L. and Sokoloff, K. L. (2005). Colonialism, Inequality, and Long-Run Paths of Development. *National Bureau of Economic Research Working Paper Series,* No. 11057.

Espinoza, R. A., Prasad, A. and Leon, H. (2010). *Estimating The Inflation-Growth Nexus-A Smooth Transition Model*. International Monetary Fund.

Evans, M. (2011). *Exchange-Rate Dynamics*. Princeton University Press.

Fischer, B. and Mayer, T. (1980). *On the structuralist view of inflation in some Latin American countries: A reassessment*. Kiel Institute for the World Economy.

Fischer, S. (1983). Inflation and Growth. *National Bureau of Economic Research Working Paper Series,* No. 1235.

Fischer, S. (1991). Growth, macroeconomics, and development. In: *NBER Macroeconomics Annual 1991, Volume 6*. MIT Press, pp. 329-379.

Fischer, S. (1993). The role of macroeconomic factors in growth. *Journal of Monetary Economics,* 32(3), 485-512.

Fischer, S. and Modigliani, F. (1978). Towards An Understanding of the Real Effects and Costs of Inflation. *National Bureau of Economic Research Working Paper Series,* No. 303.

Frankenhoff, C. A. (1962). The Prebisch Thesis: A Theory of Industrialism for Latin America. *Journal of Inter-American Studies,* 4(2), 185-206.

Franko, P. (2007). *The Puzzle of Latin American Economic Development*. Rowman & Littlefield.

Frenkel, R. and Rapetti, M. (2010). *A concise history of exchange rate regimes in Latin America*. Washington, D.C.: Center for Economic and Policy Research.

Frenkel, R. and Rapetti, M. (2011). Exchange Rate Regimes in Latin America. In: Ocampo, J. A. and Ros, J. eds. *The Oxford Handbook of Latin American Economics*. New York: Oxford University Press.

Friedman, M. and Allen, G. C. (1970). *The counter-revolution in monetary theory: first Wincott memorial lecture, delivered at the Senate House, University of London, 16 September, 1970*. Wincott Foundation.

Froot, K. A. (1989). Consistent covariance matrix estimation with cross-sectional dependence and heteroskedasticity in financial data. *Journal of Financial and Quantitative Analysis,* 24(03), 333-355.

Froot, K. A. and Rogoff, K. (1995). Perspectives on PPP and long-run real exchange rates. *Handbook of international economics,* 3, 1647-1688.

FTSE. (2012). *Ground Rules for the Management of the FTSE Global Equity Index Series*. June ed. London: Financial Times Stock Exchange Group

Furtado, C. (1965). Development and stagnation in Latin America: A structuralist approach. *Studies in Comparative International Development,* 1(11), 159-175.

Furtado, C. (1976). *Economic development of Latin America: historical background and contemporary problems*. Second ed. New York, NY: Cambridge University Press.

Gala, P. (2008). Real exchange rate levels and economic development: theoretical analysis and econometric evidence. *Cambridge Journal of Economics,* 32(2), 273-288.

Gavin, M. and Perotti, R. (1997). Fiscal policy in latin america. In: *NBER Macroeconomics Annual 1997, Volume 12*. Mit Press, pp. 11-72.

Ghosh, A. and Phillips, S. (1998). Warning: Inflation May Be Harmful to Your Growth. *Staff Papers - International Monetary Fund,* 45(4), 672-710.

Giuliano, P. and Ruiz-Arranz, M. (2009). Remittances, financial development, and growth. *Journal of Development Economics,* 90(1), 144-152.

Goldfajn, I. and Valdes, R. (1999). The Aftermath of Appreciations. *The Quarterly Journal of Economics,* 114(1), 229-262.

González, A., Teräsvirta, T. and Dijk, D. v. (2005). *Panel smooth transition regression models*. SSE/EFI Working Paper Series in Economics and Finance.

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica,* 37(3), 424-438.

Greene, W. H. (1993). *Econometric Analysis*. New York, NY: Collier Macmillan.

Greene, W. H. (2012). *Econometric Analysis*. New Jersey, NJ: Prentice Hall.

Greenidge, K., Craigwell, R., Thomas, C. and Drakes, L. (2012). Threshold Effects of Sovereign Debt: Evidence from the Caribbean. *International Monetary Fund Working Papers,* 12/157.

Guerrero, F. (2006). Does inflation cause poor long-term growth performance? *Japan and the World Economy,* 18(1), 72-89.

Gutierrez, M. A. (2005). *Economic Growth in Latin America: The Role of Investment And Other Growth Sources*. United Nations. Economic Commission for Latin America and the Caribbean. Economic Development Division.

Hahn, J. and Hausman, J. (2002). Notes on bias in estimators for simultaneous equation models. *Economics Letters,* 75(2), 237-241.

Hansen, B. E. (1996). Inference When a Nuisance Parameter Is Not Identified Under the Null Hypothesis. *Econometrica,* 64(2), 413-430.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics,* 93(2), 345-368.

Hansen, B. E. (2000). Sample Splitting and Threshold Estimation. *Econometrica,* 68(3), 575-603.

Hansen, G. D. and Prescott, E. C. (2002). Malthus to Solow. *The American Economic Review,* 92(4), 1205-1217.

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

Harris, R. G. (2001). Is There a Case for Exchange-Rate-Induced Productivity Changes?. *Centre for International Economic Studies, Adelaide University,* Discussion Paper: 0110.

Harrod, R. F. (1933). *International economics*. London: James Nisbet and Cambridge University Press.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica,* 46(6), 1251-1271.

Hausmann, R. and Panizza, U. (2003). On the determinants of Original Sin: an empirical investigation. *Journal of International Money and Finance,* 22(7), 957-990.

Hausmann, R., Panizza, U. and Stein, E. (2001). Why do countries float the way they float? *Journal of Development Economics,* 66(2), 387-414.

Heij, C., De Boer, P., Franses, P. H., Kloek, T. and Van Dijk, H. K. (2004). *Econometric methods with applications in business and economics*. Oxford University Press.

Henisz, W. (2012). *Political Constraint Index (POLCON) Dataset*

Hercowitz, Z. (1998). The 'embodiment' controversy: A review essay. *Journal of Monetary Economics,* 41(1), 217-224.

Heston, A., Summers, R. and Aten, B. (2012). *Penn World Table Version 7.1*. November 2012 ed. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

Hirschman, A. O. (1949). Devaluation and the Trade Balance: A Note. *The Review of Economics and Statistics,* 31(1), 50-53.

Hirschman, A. O. (1968). The Political Economy of Import-Substituting Industrialization in Latin America. *The Quarterly Journal of Economics,* 82(1), 1-32.

Hodrick, R. J. and Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking,* 29(1), 1-16.

Hofstetter, M. (2008). Disinflations in Latin America and the Caribbean: A free lunch? *Journal of Macroeconomics,* 30(1), 327-345.

Holtz-Eakin, D., Newey, W. and Rosen, H. S. (1988). Estimating Vector Autoregressions with Panel Data. *Econometrica,* 56(6), 1371-1395.

Hummels, D., Ishii, J. and Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics,* 54(1), 75-96.

Husain, A. M., Mody, A. and Rogoff, K. S. (2005). Exchange rate regime durability and performance in developing versus advanced economies. *Journal of Monetary Economics,* 52(1), 35-64.

Ilzetzki, E., Mendoza, E. G. and Végh, C. A. (2013). How big (small?) are fiscal multipliers? *Journal of Monetary Economics,* 60(2), 239-254.

Ilzetzki, E., Reinhart, C. and Rogoff, K. (2008). *Exchange Rate Arrangements Entering the 21st Century: Which Anchor Will Hold?* Unpublished Manuscript.

Ilzetzki, E., Reinhart, C. and Rogoff, K. (2011). *The Country Chronologies and Background Material to Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?* Mimeo.

International Monetary Fund (2012a). *Growth Resuming, Dangers Remain*. April ed. World Economic and Financial Surveys. Washington, D.C.: International Monetary Fund.

International Monetary Fund (2012b). *International Financial Statistics*. June ed. Washington, D.C.: International Monetary Fund.

Islam, N. (1995). Growth Empirics: A Panel Data Approach. *The Quarterly Journal of Economics,* 110(4), 1127-1170.

ISO/3166-1 (2006). *Codes for the representation of names of countries and their subdivisions--Part 1: Country codes, ISO 3166-1 Alpha 3*. Geneva, Switzerland: International Organization on Standardization

Ito, T., Isard, P. and Symansky, S. (1999). Economic growth and real exchange rate: an overview of the Balassa-Samuelson hypothesis in Asia. In: *Changes in Exchange Rates in Rapidly Developing Countries: Theory, Practice, and Policy Issues (NBER-EASE volume 7).* University of Chicago Press, pp. 109-132.

J.P. Morgan (1999). *Introducing the J.P. Morgan Emerging Markets Bond Index Global (EMBI Global).* Methodology brief. New York: J.P. Morgan Securities Inc.

Johnson, S., Ostry, J. D. and Subramanian, A. (2007). The Prospects for Sustained Growth in Africa: Benchmarking the Constraints. *National Bureau of Economic Research Working Paper Series,* No. 13120.

Judson, R. and Orphanides, A. (1999). Inflation, Volatility and Growth. *International Finance,* 2(1), 117-138.

Kaminsky, G. L. and Pereira, A. (1996). The debt crisis: lessons of the 1980s for the 1990s. *Journal of Development Economics,* 50(1), 1-24.

Kandil, M. (2004). Exchange Rate Fluctuations and Economic Activity in Developing Countries: Theory and Evidence. *Journal of Economic Development,* 29(1), 85-108.

Kay, C. (1991). Reflections on the Latin American Contribution to Development Theory. *Development and Change,* 22(1), 31-68.

Khan, M. S. and Senhadji, A. S. (2001). Threshold Effects in the Relationship between Inflation and Growth. *IMF Staff Papers,* 48(1), 1-21.

Kiguel, M. A. and Liviatan, N. (1988). Inflationary Rigidities and Orthodox Stabilization Policies: Lessons from Latin America. *The World Bank Economic Review,* 2(3), 273-298.

Kleibergen, F. and Paap, R. (2006). Generalized reduced rank tests using the singular value decomposition. *Journal of Econometrics,* 133(1), 97-126.

Kleibergen, F. and Schaffer, M. E. (2013). RANKTEST: Stata module to test the rank of a matrix using the Kleibergen-Paap rk statistic. *Statistical Software Components*.

Kneller, R., Bleaney, M. F. and Gemmell, N. (1999). Fiscal policy and growth: evidence from OECD countries. *Journal of Public Economics,* 74(2), 171-190.

Knight, M., Loayza, N. and Villanueva, D. (1993). Testing the Neoclassical Theory of Economic Growth: A Panel Data Approach. *Staff Papers - International Monetary Fund,* 40(3), 512-541.

Kormendi, R. C. and Meguire, P. G. (1985). Macroeconomic determinants of growth: Cross-country evidence. *Journal of Monetary Economics,* 16(2), 141-163.

Kourtellos, A., Stengos, T. and Tan, C. M. (2007). *Threshold regression with endogenous threshold variables*. Department of Economics Working Paper. Nicosia: University of Cyprus.

Kremer, S., Bick, A. and Nautz, D. (2013). Inflation and growth: new evidence from a dynamic panel threshold analysis. *Empirical Economics,* 44(2), 861-878.

Krueger, A. O. (1968). Factor Endowments and Per Capita Income Differences among Countries. *The Economic Journal,* 78(311), 641-659.

Krugman, P. (1994). Competitiveness: A Dangerous Obsession. *Foreign Affairs,* 73(2), 28-44.

Krugman, P. and Taylor, L. (1978). Contractionary effects of devaluation. *Journal of International Economics,* 8(3), 445-456.

Kydland, F. E. and Prescott, E. C. (1990). Business Cycles: Real Facts and a Monetary Myth. *Federal Reserve Bank of Minneapolis Quarterly Review,* 14(2), 3-18.

Laeven, L. and Valencia, F. (2010). Resolution of Banking Crises: The Good, the Bad, and the Ugly. *International Monetary Fund Working Papers,* No. 10/146.

Laeven, L. and Valencia, F. (2012). Systemic Banking Crises Database: An Update. *International Monetary Fund Working Papers,* No. 12/163.

Laidler, D. (1981). Monetarism: An Interpretation and an Assessment. *The Economic Journal,* 91(361), 1-28.

Layard, R., Mayraz, G. and Nickell, S. (2009). Does relative income matter? Are the critics right? *CEP Discussion Paper,* No. 918. Centre for Economic Performance, London School of Economics and Political Science.

Leamer, E. E. (1983). Let's take the con out of econometrics. *The American Economic Review*, 31-43.

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

Lee, J.-W. (1995). Capital goods imports and long-run growth. *Journal of Development Economics,* 48(1), 91-110.

Levine, R., Loayza, N. and Beck, T. (2000). Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics,* 46(1), 31-77.

Levine, R. and Renelt, D. (1992). A Sensitivity Analysis of Cross-Country Growth Regressions. *The American Economic Review,* 82(4), 942-963.

Levine, R. and Zervos, S. (1996). Stock Market Development and Long-Run Growth. *The World Bank Economic Review,* 10(2), 323-339.

Levine, R. and Zervos, S. J. (1993). What we Have Learned about Policy and Growth from Cross-Country Regressions? *The American Economic Review,* 83(2), 426-430.

Levy-Yeyati, E. and Sturzenegger, F. (2005). Classifying exchange rate regimes: Deeds vs. words. *European Economic Review,* 49(6), 1603-1635.

Levy-Yeyati, E. and Sturzenegger, F. (2010). Chapter 64 - Monetary and Exchange Rate Policies. In: Dani, R. and Mark, R. eds. *Handbook of Development Economics*. Vol. 5. Elsevier, pp. 4215-4281.

Levy-Yeyati, E., Sturzenegger, F. and Reggio, I. (2010). On the endogeneity of exchange rate regimes. *European Economic Review,* 54(5), 659-677.

Lin, H.-Y. and Chu, H.-P. (2013). Are fiscal deficits inflationary? *Journal of International Money and Finance,* 32(0), 214-233.

Lizondo, J. S. and Montiel, P. J. (1989). Contractionary Devaluation in Developing Countries: An Analytical Overview. *Staff Papers - International Monetary Fund,* 36(1), 182-227.

López-Villavicencio, A. and Mignon, V. (2011). On the impact of inflation on output growth: Does the level of inflation matter? *Journal of Macroeconomics,* 33(3), 455-464.

Lora, E. (2001). Structural Reforms in Latin America: What Has Been Reformed and How to Measure It. *Inter-American Development Bank,* Working Paper No. 466.

Lora, E. and Panizza, U. (2002). Structural Reforms in Latin America Under Scrutiny. *Inter-American Development Bank,* Working Paper No. 470.

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

Maddison, A. (2001). *The World Economy: A Millennial Perspective*. Paris, France: Organisation for Economic Co-operation and Development.

Mankiw, N. G., Romer, D. and Weil, D. N. (1992). A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics,* 107(2), 407-437.

Mazumdar, J. (2001). Imported machinery and growth in LDCs. *Journal of Development Economics,* 65(1), 209-224.

McCallum, B. T. (1990). Chapter 18 Inflation: Theory and evidence. In: Benjamin, M. F. and Frank, H. H. eds. *Handbook of Monetary Economics*. Vol. Volume 2. Elsevier, pp. 963-1012.

Mishkin, F. S. and Savastano, M. A. (2001). Monetary policy strategies for Latin America. *Journal of Development Economics,* 66(2), 415-444.

Morley, S. A., Machado, R. and Pettinato, S. (1999). *Indexes of structural reform in Latin America*. Vol. 12. United Nations Economic Commission for Latin America and the Caribbean (CEPAL).

Mundell, R. (1963). Inflation and Real Interest. *Journal of Political Economy,* 71(3), 280-283.

Murray, M. P. (2006). Avoiding Invalid Instruments and Coping with Weak Instruments. *The Journal of Economic Perspectives,* 20(4), 111-132.

Naím, M. (1994). Latin America: the second stage of reform. *Journal of Democracy,* 5(4), 32-48.

Nazmi, N. (1997). Exchange rate-based stabilization in Latin America. *World Development,* 25(4), 519-535.

Newey, W. K. and West, K. D. (1994). Automatic lag selection in covariance matrix estimation. *The Review of Economic Studies,* 61(4), 631-653.

Nickell, S. (1981). Biases in Dynamic Models with Fixed Effects. *Econometrica,* 49(6), 1417-1426.

North, D. C. (1989). Institutions and economic growth: An historical introduction. *World Development,* 17(9), 1319-1332.

North, D. C. (1991). Institutions. *The Journal of Economic Perspectives,* 5(1), 97-112.

North, D. C. (1994). Economic Performance Through Time. *The American Economic Review,* 84(3), 359-368.

Nurkse, R. (1952). Some International Aspects of the Problem of Economic Development. *The American Economic Review,* 42(2), 571-583.

Obstfeld, M. and Rogoff, K. (1996). *Foundations of international macroeconomics*. Cambridge, Mass. and London: MIT Press.

Ocampo, J. A. (2009). Latin America and the global financial crisis. *Cambridge Journal of Economics,* 33(4), 703-724.

Pagés, C. (2010). *The Age of Productivity: Transforming Economies from the Bottom Up*. Palgrave Macmillan.

Parente, S. and Prescott, E. (2002). *Barriers to riches*. Vol. 3. Cambridge, MA: The MIT Press.

Parente, S. and Prescott, E. (2005). Chapter 21 A Unified Theory of the Evolution of International Income Levels. In: Philippe, A. and Steven, N. D. eds. *Handbook of Economic Growth*. Vol. 1, Part B. Elsevier, pp. 1371-1416.

Paus, E. (2004). Productivity Growth in Latin America: The Limits of Neoliberal Reforms. *World Development,* 32(3), 427-445.

Paus, E., Reinhardt, N. and Robinson, M. (2003). Trade Liberalization and Productivity Growth in Latin American Manufacturing, 1970-98. *The Journal of Policy Reform,* 6(1), 1-15.

Pick, D. H. and Vollrath, T. L. (1994). Real Exchange Rate Misalignment and Agricultural Export Performance in Developing Countries. *Economic Development and Cultural Change,* 42(3), 555-571.

Prebisch, R. (1950). *The economic development of Latin America and its principal problems*. Lake Success, NY: United Nations.

Prebisch, R. (1959). Commercial Policy in the Underdeveloped Countries. *The American Economic Review,* 49(2), 251-273.

Ravn, M. O. and Uhlig, H. (2002). On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations. *The Review of Economics and Statistics,* 84(2), 371-376.

Razmi, A., Rapetti, M. and Skott, P. (2012). The real exchange rate and economic development. *Structural Change and Economic Dynamics,* 23(2), 151-169.

Rebelo, S. (1991). Long-Run Policy Analysis and Long-Run Growth. *Journal of Political Economy,* 99(3), 500-521.

Reinhart, C. and Rogoff, K. (2004). The Modern History of Exchange Rate Arrangements: A Reinterpretation. *The Quarterly Journal of Economics,* 119(1), 1-48.

Reinhart, C. and Rogoff, K. (2009). *This Time is Different: Eight Centuries of Financial Folly*. Princeton University Press.

Reinhart, C. and Rogoff, K. (2010). From Financial Crash to Debt Crisis. *National Bureau of Economic Research Working Paper Series,* No. 15795.

Rennhack, R. and Nozaki, M. (2006). Financial Dollarization in Latin America. *International Monetary Fund Working Papers,* No. 06/7.

Robinson, W. I. (2004). Global Crisis and Latin America. *Bulletin of Latin American Research,* 23(2), 135-153.

Rodriguez, F. and Rodrik, D. (2001). Trade policy and economic growth: a skeptic's guide to the cross-national evidence. In: *NBER Macroeconomics Annual 2000, Volume 15*. MIT PRess, pp. 261-338.

Rodrik, D. (2008). The Real Exchange Rate and Economic Growth. *Brookings Papers on Economic Activity,* 2008, 365-412.

Rodrik, D., Subramanian, A. and Trebbi, F. (2004). Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development. *Journal of Economic Growth,* 9(2), 131-165.

Rogers, W. (1994). Regression standard errors in clustered samples. *Stata technical bulletin,* 3(13).

Rogoff, K. (1996). The Purchasing Power Parity Puzzle. *Journal of Economic Literature,* 34(2), 647-668.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy,* 94(5), 1002-1037.

Romer, P. M. (1994). The Origins of Endogenous Growth. *The Journal of Economic Perspectives,* 8(1), 3-22.

Roodman, D. (2009a). How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal,* 9(1), 86-136.

Roodman, D. (2009b). A note on the theme of too many instruments*. *Oxford Bulletin of Economics and Statistics,* 71(1), 135-158.

Rousseau, P. L. and Wachtel, P. (2002). Inflation thresholds and the finance–growth nexus. *Journal of International Money and Finance,* 21(6), 777-793.

Samuelson, P. A. (1964). Theoretical Notes on Trade Problems. *The Review of Economics and Statistics,* 46(2), 145-154.

Sarel, M. (1996). Nonlinear Effects of Inflation on Economic Growth. *IMF Staff Papers,* 43(1), 199-215.

Sargan, J. D. (1958). The Estimation of Economic Relationships using Instrumental Variables. *Econometrica,* 26(3), 393-415.

Sarno, L. and Taylor, M. P. (2002). *The Economics of Exchange Rates*. Cambridge University Press.

Schaffer, M. E. (2010). *XTIVREG2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models*. S456501. Boston College Department of Economics.

Schaffer, M. E. (2012). xtivreg2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models. *Statistical Software Components*.

Seers, D. (1962). A Theory of Inflation and Growth in Under-Developed Economies Based on the Experience of Latin America. *Oxford Economic Papers,* 14(2), 173-195.

Sidrauski, M. (1967). Inflation and Economic Growth. *Journal of Political Economy,* 75(6), 796-810.

Singer, H. (1950). The Distribution of Gains between Investing and Borrowing Countries. *The American Economic Review,* 40(2), 473-485.

Solimano, A. and Soto, R. (2005). *Economic growth in Latin America in the late 20th century: evidence and interpretation*. Vol. 33. United Nations Publications.

Solow, R. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics,* 70(1), 65-94.

Solow, R. (2005). Reflections on Growth Theory. In: Philippe, A. and Steven, N. D. eds. *Handbook of Economic Growth*. Vol. 1, Part A. Elsevier, pp. 3-10.

Staiger, D. and Stock, J. H. (1997). Instrumental Variables Regression with Weak Instruments. *Econometrica,* 65(3), 557-586.

Standard & Poor's (2012). *S&P Indices: S&P Global BMI, S&P/IFCI Methodologies*. Standard & Poor's Financial Services LLC.

Stock, J. H. and Watson, M. W. (2008). Heteroskedasticity-Robust Standard Errors for Fixed Effects Panel Data Regression. *Econometrica,* 76(1), 155-174.

Stock, J. H., Wright, J. H. and Yogo, M. (2002). A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments. *Journal of Business & Economic Statistics,* 20(4), 518-529.

Stock, J. H. and Yogo, M. (2005). Testing for weak instruments in linear IV regression. *Identification and inference for econometric models: Essays in honor of Thomas Rothenberg,* 1.

Stockman, A. C. (1981). Anticipated inflation and the capital stock in a cash in-advance economy. *Journal of Monetary Economics,* 8(3), 387-393.

Swan, T. W. (1956). Eeconomic Growth and Capital Accumulation. *Economic Record,* 32(2), 334-361.

Taylor, A. M. (1998). On the Costs of Inward-Looking Development: Price Distortions, Growth, and Divergence in Latin America. *The Journal of Economic History,* 58(01), 1-28.

Temple, J. (2000). Inflation and Growth: Stories Short and Tall. *Journal of Economic Surveys,* 14(4), 395.

Tobin, J. (1965). Money and Economic Growth. *Econometrica,* 33(4), 671-684.

Toulaboe, D. (2006). Real exchange rate misalignment and economic growth in developing countries. *Southwestern Economic Review,* 33(1), 57-74.

Wallis, W. A. (1960). Price Stability And Economic Growth. *Increasing Understanding of Public Problems and Policies*, 145-157.

Wang, C.-H. and Lin, E. S. (2010). *Panel Threshold Regression Models with Endogenous Threshold Variables*. National Taipei University. Unpublished Manuscript.

Williams, R. L. (2000). A note on robust variance estimation for cluster-correlated data. *Biometrics,* 56(2), 645-646.

Williamson, J. (1990). What Washington means by policy reform. In: Williamson, J. ed. *Latin American adjustment : how much has happened?* Washington, DC: Institute for International Economics.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics,* 126(1), 25-51.

Wooldridge, J. (2012). *Introductory Econometrics: A Modern Approach*. Cengage Learning.

Wooldridge, J. M. (2001). Applications of Generalized Method of Moments Estimation. *The Journal of Economic Perspectives,* 15(4), 87-100.

World Bank (2013). *World Development Indicators (WDI) Database*.

Wu, D.-M. (1973). Alternative Tests of Independence between Stochastic Regressors and Disturbances. *Econometrica,* 41(4), 733-750.