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Three essays on the Ecuador's economy

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Resumen

Esta tesis doctoral presenta tres ensayos sobre la economía del Ecuador. Su propósito es estudiar las dinámicas de su crecimiento y los factores que han jugado un papel importante. Así también se analiza la asignación de los recursos públicos entre los gobiernos central y subnacional, haciendo énfasis en el cumplimiento de los criterios de eficiencia y equidad. Para lograr los objetivos de cada ensayo, se ha contado con información estadística proveniente de fuentes oficiales como el Banco Central del Ecuador (BCE), el Instituto Nacional de Estadísticas y Censos (INEC), la Secretaría Nacional de Planificación y Desarrollo (Senplades) y el Ministerio de Economía y Finanzas (MEF) para realizar las estimaciones de los modelos económicos propuestos en cada uno de los ensayos, por lo que la contribución de esta tesis no es solo teórica sino también empírica.

En el primer ensayo, "Determinants of Total Factor Productivity in Ecuador" se explican los hechos más relevantes de la economía ecuatoriana durante el periodo 1950-2014. Se propone una ecuación no lineal para explicar la productividad total de los factores (PTF) utilizando variables tales como el capital humano, la inversión, el índice general de precios, así como variables específicas de la economía ecuatoriana como el precio del petróleo y un índice para la corrupción. Los resultados muestran que el capital humano y la inversión en infraestructura tienen un impacto positivo sobre la PTF, mientras que el impacto del índice general de precios es negativo. El petróleo también tiene un impacto positivo, aunque al parecer éste no es directo.

El segundo ensayo, "Public Investment Allocation across Ecuadorian Provinces" analiza la asignación de recursos por parte del gobierno central hacia los gobiernos seccionales durante el periodo 2008-2015. Se propone un modelo teórico y se usa un panel de datos con información

estadística de las 24 provincias del país para estimar una ecuación para la tasa de crecimiento de la inversión pública per cápita del gobierno central. El objetivo de este ensayo es determinar el cumplimiento de los criterios de eficiencia, equidad y necesidades de infraestructura especial en la asignación de recursos financieros públicos. Los resultados indican que el gobierno central ha logrado mantener un equilibrio entre eficiencia y equidad durante el periodo de tiempo analizado. Además, los resultados sugieren una relación positiva entre la inversión pública del gobierno central hacia las provincias cuyos representantes políticos tienen afinidad con el presidente Correa.

El tercer ensayo, "Fiscal Decentralization and the Allocation of Public Spending of Subnational Governments: The case of Ecuador" analiza la asignación de recursos financieros de los gobiernos seccionales durante el periodo 2001-2015. El objetivo de este ensayo es evaluar los criterios de asignación de recursos públicos por parte de los gobiernos seccionales, haciendo énfasis en los efectos de la descentralización fiscal. Los resultados muestran una relación positiva entre la autonomía financiera y el crecimiento de la inversión pública. Además, se encuentra, por un lado, una relación positiva entre la autonomía financiera y la tasa de crecimiento del gasto corriente per cápita; y, por otro lado, éste está negativamente relacionado con la autonomía tributaria. Tal resultado, sugiere que tales efectos quedan anulados.

Abstract

This doctoral thesis presents three essays on the Ecuadorian's economy. Its purpose is to study the dynamics of its growth and the factors that have played a key role. It also analyzes the allocation of public resources between the central and subnational governments, emphasizing compliance with the criteria of the efficiency and equity. To achieve the purpose of each essay, statistical information from official sources such as the Central Bank of Ecuador, the National Institute of Statistics and Censuses, the National Secretariat for Planning and Development and the Ministry of Economy and Finance has been used, to estimate the economic models proposed in each of the essays, so the contribution of this thesis is not only theoretical but also empirical.

In the first essay, "Determinants of Total Factor Productivity in Ecuador" the most relevant events of the Ecuadorian economy during the period 1950-2014 are explained. A non-linear equation for the total factor productivity (TFP) is proposed. Variables suggested by the literature such as human capital, public infrastructure, FDI, fertility rate and general price index are included as explanatory variables, as well as, specific variables considered to be relevant for the Ecuadorian economy, such as, the oil price and a corruption index. The results show that human capital and public infrastructure have positive impacts on TFP, while the impact of general price index is negative. Oil also has a positive impact, although, apparently, the relationship between oil and TFP is not direct.

In the second essay, "Public Investment Allocation across Ecuadorian Provinces" we analyze the allocation of resources by the central government to subnational governments during the period 2008-2015. A theoretical model is proposed to obtain an equation for the growth rate of the public investment per capital of the central government. For the estimation, panel data for the 24 provinces of the country are used. The objective of this essay is to determine compliance with the criteria of efficiency, equity and special infrastructure needs in the allocation of

public financial resources. The results show that the central government has managed to deal with the criteria of efficiency and equity during the period of time analyzed. Furthermore, the results suggest a positive relationship between public investment by the central government in provinces whose political representatives have an affinity with President Correa.

In the third essay, "Fiscal Decentralization and the Allocation of Public Spending of Subnational Governments: The case of Ecuador" we analyze the allocation of financial resources of subnational governments during the period 2001-2015. The objective of this essay is to evaluate the criteria for the allocation of public resources by sectional governments, emphasizing the effects of provincial decentralization. The results show a positive relationship between the financial autonomy and the growth of public investment per capita. However, mixed results for the growth rate of the current spending per capita suggest, in general, that it is not related to decentralization.

Chapter 1
Introduction

From its beginnings as a Republic, Ecuador's economy has been characterized by being highly dependent on exports of its raw materials. During the last 50 years, oil has played a major role, which has made the economy unstable and vulnerable to internal and external shocks. This dependence on its natural resources has prevented the country from developing other economic sectors less vulnerable to external and internal impacts and having a competitive and innovative industrial sector. Despite the economic models implemented and the state economic policies adopted in recent decades by the governments, whether democratic or dictatorships, Ecuador continues to be a primary-exporting country.

The rents generated by the bonanzas of its raw materials (bananas and oil) allowed the construction of some important infrastructure works at the national level, especially in the areas where the country's economic, commercial and financial activity was mainly concentrated. As a result of that, inequality and poverty gaps between the regions and provinces of the country increases, and not only between urban and rural areas, but also between the urban areas of the same city. According to data from the National Institute of Statistics and Censuses, the Gini coefficient at the national level reached 0.472 in June 2018, while the incidence of poverty and extreme poverty were 24.5% and 9.0%, respectively. That same year, Ecuador registered an economic growth of 1.4% according to data from the Central Bank.

For many economic analysts and researchers, these booms, especially the oil boom, could have caused the so-called “Dutch disease” or “the curse of natural resources” (Naranjo, 2006; Acosta, 2009; Espín et al., 2020). Gylfason (2001), Torvik (2001), among others, described the aforementioned misfortune as one in which a country well-endowed with non-renewable natural resources has difficulties to consolidate its economic growth and development in the medium and long term, due to the volatility of the prices of raw materials, but also to the poor management of the resources generated by these products. According to Edwards (1995), in the presence of natural resource booms, governments try to protect this sector to the detriment of the other productive sectors of the country, so that, little by little, some sectors remains lagged, which

becomes unsustainable when the bonanza ceases and causing economic, political and social crises.

In addition to the aforementioned dependence on its natural resources, other factors have contributed to the characteristic volatility and fragility of the Ecuadorian economy such as natural disasters ("El Niño" meteorological phenomenon, earthquakes, droughts) causing millions in losses to the country, conflicts war with Peru, the foreign debt crisis of the 1980s, the financial crisis of 1999, the loss of the national currency (El Sucre) to adopt the US dollar as currency and the world financial crisis of 2008. In addition to that, Ecuador has also shown an unprecedented political instability with up to five presidents in ten years (ECB, 2010). Despite this scenario, Ecuador has performed better, in terms of economic growth, than most of its neighboring Latin American countries (De Gregorio, 1992) and in recent years, has shown fairly balanced macroeconomic indicators (BCE, 2010; ECLAC, 2018). It should be mentioned that, in addition to dollarization, the remittances sent by Ecuadorian migrants prevented the country from entering a deep depression after the 1999 financial crisis (IADB, 2008). This, together with what would be the second oil boom between 2003-2014 (ECLAC, 2017) has allowed the country to achieve some economic, political and social stability in recent years.

During the second oil boom, the State has also been able to implement development plans such as the National Development Plan, also known as the Plan for Good Living (Plan para el Buen Vivir), which, among its main objectives, is to reduce the gaps of poverty and inequality through a change of the structure of the economy in order to move Ecuador from being a primary-exporting country to a producer of goods and services with added value (Senplades, 2010). The Tax Regime Law would also be reformed to control the procyclicality of the national economy with respect to the international prices of its raw materials so that public current expenses are financed by tax revenues. The oil revenues during this second boom have allowed the state to increase its spending for the construction of large infrastructure projects such as hydroelectric plants, link roads, hospitals and educational centers (Senplades, 2014).

Decentralization is also another important aspect for the country's economy since, being a small country with a unitary form of government, Ecuador has been characterized by a great concentration of power in the central government, which, in addition to the agglomeration of the economic activity in few cities, has probably been an obstacle to the economic growth and development of the country, as well as to the reduction of

inequalities between provinces and cantons. Thus, the National Decentralization Plan, framed in the 2008 Constitution, obliges the Central Government to progressively and definitively transfer powers and resources to sectional governments so that they can manage more public spending (Senplades, 2012). However, the high political fragmentation and continuous regional struggles have been obstacles, so that, several of the objectives set out in both the Plan for Good Living and the Decentralization Plan have not been fully met.

Therefore, the objective of this thesis is to analyze some interesting aspects of the economy of Ecuador, both nationally and at the provincial level. At the national level, a study is made of economic growth from the perspective of total factor productivity (TFP) and the determinants of its growth, while at the provincial level, we concentrate on the criteria for the allocation of public resources of the Central Government and of sectional governments, thus providing information on the economy of Ecuador as a whole. The three essays presented below in this document contribute to the empirical literature on economic growth in a developing country and propose methodologies that will help to better understand the allocation of public spending in this Latin American country.

In Chapter 2, the essay entitled "Determinants of Total Factor Productivity in Ecuador", we analyze the economic growth of Ecuador during the period 1950-2014. A brief review of the most relevant economic events in the country is carried out. A non-linear for the total factor productivity (TFP) is specified. TFP is assumed capture the internal and external shocks that the country has suffered and accounts for volatility of the Ecuadorian economy. Variables considered by the economic literature as relevant to explain the economic growth of a country such as human capital, foreign direct investment, public infrastructure, general price index and fertility rate (Isaksson, 2007) have been taken into account. Likewise, specific variables have been considered in the analysis that affects the behaviour of the Ecuadorian economy, such as the price of oil and a corruption index, which includes political instability and institutional fragility, something very characteristic of the Ecuadorian economy. The results show that the variables that have contributed the most to TFP are human capital and public infrastructure, while the relationship between the general price index and TFP is negative. Likewise, it is observed that oil has a positive impact on the Ecuadorian economy, although this impact could have been indirectly on TFP due to the fact that oil revenues have been used to create infrastructure works at the national level. It is worth

mentioning that some specific periods in the country's history have caused a structural break in TFP, such as the stages where the ISI import substitution model was implemented.

The second essay, chapter 3 "Public Investment Allocation across Ecuadorian Provinces" analyses the allocation of public resources by the Central Government to the provinces during the period 2008-2015. We propose a theoretical model in which the central planner maximizes a social welfare function that allows him/her to optimize public investment at the sectional level. Political factors have also been considered. This essay evaluates the achievement of the criteria for the allocation of public resources: efficiency, redistribution and special infrastructure needs for a developing country such as Ecuador. The analysis period corresponds specifically to the moment in which a development plan called the National Plan for Good Living (Senplades, 2010) is implemented during the presidency of Rafael Correa since during this time the gathering of statistical information at the provincial and cantonal level is encouraged, so data is available for analysis. The results obtained show that during the period of study, the central government was able to managed to maintain a certain balance between efficiency and equity, that is, it has managed to boost economic growth in the most productive provinces without neglecting those provinces that present the greatest lag. Likewise, the results suggest that there is a positive relationship between the growth of public investment from the central government and the share of provincial MPs of the same party of President Correa.

The third essay, chapter 4, "Fiscal Decentralization and the Allocation of Public Spending of Subnational Governments: The case of Ecuador", follows the line of the previous essay (chapter 3), but differs in the fact that this time, the analysis focuses on the allocation of public resources of the subnational governments (provincial and municipal governments). Furthermore, not only capital spending is considered, but also current spending, which is assumed to increase human capital (Diamond, 1990; Baldacci et al., 2008). Moreover, two variables to control for the effects of decentralization in the provinces are added to the equation. The results of the estimated model show that financial autonomy is positively correlated with the growth of public spending by sectional governments. In addition, financial autonomy and tax autonomy have a positive and negative relationship, respectively, with the current public spending, so there is a cancellation effect between the two variables.

Final conclusions and recommendations are presented in Chapter 5.

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Chapter 2
Determinants of Total Factor Productivity in Ecuador

Abstract

This article analyzes Ecuador's economic growth for the period 1950–2014. The study focuses particularly on total factor productivity (TFP) and proposes a nonlinear function that allows the TFP to depend on a set of explanatory variables considered in the literature to be relevant in explaining economic growth. Specific variables for the Ecuadorian case are also included. Strong empirical evidence supporting positive effects of human capital and public infrastructure on TFP is found. The results suggest that oil revenues have no direct effect on TFP. Moreover, some key periods seem to have caused structural changes in TFP. The results are robust to different specifications and estimation methods.

Key words: Ecuador; economic growth; TFP; oil.

JEL classification: O40; C20; C26

2. Determinants of Total Factor Productivity in Ecuador

2.1. Introduction

Ecuador's economic performance has been subordinated to its export commodities. Banana and oil booms have reported significant revenues to the country which have shaped its economic structure. However, such revenues do not seem to have been effectively transformed into sustained economic growth or prolonged industrial development. Hence, the industrial sector has been uncompetitive and lacking innovation, making it volatile and extremely vulnerable to internal and external shocks (Senplades, 2009; Calderón, 2016).

Over the period 1950–2014, most of the volatility characterizing Ecuador's economic growth was due to total factor productivity (TFP) since the growth rate due to inputs was fairly stable. The literature on economic growth has widely established that TFP can capture not only technology as usually assumed in the earliest theoretical model, but also many other factors such as institutional, political, cultural and geographical aspects. Moreover, country specific shocks could also affect TFP. In fact, TFP is assumed to include all factors that affect economic production other than inputs.

The aim of this article is to identify determinants of TFP in Ecuador. In order to achieve this objective, TFP is considered to be a nonlinear function of variables, other than physical inputs, which are considered in the literature to be relevant in explaining economic growth. Moreover, specific variables that could foster economic growth in Ecuador have been considered for the analysis. The TFP index built by Feenstra *et al*. (2015) and provided by the Penn World Table (PWT)[1] is the dependent variable that is used in this article.

Our specification is able to capture to a large extent the categories of variables proposed by Isaksson (2007) that have been found to affect TFP, i.e., the creation, transmission and absorption of knowledge, education and training, technology transfer

[1] The Penn World Table is a set of national-accounts data developed by the University of California, Davis, and the Groningen Growth Development Centre of the University of Groningen to measure productivity, real GDP, capital, employment and all kind of data for making comparisons across countries and over time on economic development and growth.

and adoption, infrastructure, quality of institutions, the social dimension, structural changes and the integration and trade.

The objective of this article could be also framed within the literature on institutions and economic growth (North, 1990; Hall and Jones, 1999; Rodrik *et al.*, 2004; Dixit, 2009) which claims that the output per worker is mainly driven by the quality of institutions and government policies. This literature attempts to explain why some underdeveloped countries have been able to absorb technological progress from developed countries better than others and eventually converge in terms of per capita income, as well as why some countries rich in natural resources still persist in a chronic industrial lag and therefore remain developing economies.

We are aware of the drawbacks of a single country study like this in comparison to a multiple country study. However, our focus on Ecuador is justified because its economy has performed, on average, much better than its neighboring countries, even those with similar characteristics such as oil dependency. According to De Gregorio (1992), Ecuador performed better than other Latin American countries due precisely to the bonanza experienced from the 1950s to the 1970s. In fact, Ecuador's annual average economic growth rate over the analyzed period has been higher than that of the average of the seven largest Latin American countries.[2] Moreover, Ecuador's economic growth rate is the highest among the main net oil exporter countries in the region.[3] The comparison with Venezuela, which was the major oil-exporting country in the region and whose average annual economic growth rate was the lowest during the period 1950–2014, is striking. In fact, Agnani and Iza (2011) demonstrated that although Venezuela is an oil abundant country its economic growth is due to the evolution of its non-oil GDP and the aforementioned authors suggested that Venezuela is immersed in a great depression. However, this is not the case of Ecuador.

The fact that Ecuador's economic growth is conditioned on the evolution of the prices of its main export commodities (banana until the late 1960s and oil after that) has meant that the country may have suffered the so-called "curse of natural resource" (Sachs and Warner, 1995, 2001) or "Dutch disease" (Corden and Neary, 1982; Gylfason, 2001; Torvik, 2001) as various authors suggest (Naranjo, 1995; Fontaine, 2002). However, we consider that countries like Ecuador are not condemned to suffer a

[2] The seven largest Latin American economies are: Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.
[3] The net oil exporter countries of the region are: Venezuela, Mexico, Colombia, and Ecuador.

prolonged disease or curse, since there are factors contained in the TFP that can help to overcome such a misfortune.

The empirical results show that the main variables that enhance TFP in Ecuador are human capital and public infrastructure, while consumer price index diminishes TFP. Moreover, some key periods have been found to have caused a structural break in TFP. Although the oil industry is considered the driver of the Ecuadorian economy since its revenues have allowed the funding of major national projects, oil prices seem to have no direct effect on TFP. The empirical results provided in this article suggest that the positive effects of oil prices on economic growth in Ecuador might accrue through the accumulation of inputs or any other factor, rather than through TFP. Furthermore, it is thought that oil has an indirect effect on TFP because oil revenues fund public investment in infrastructure and education.

The article is structured as follows. An overview of Ecuador's economic performance over the period 1950–2014 is provided in section 2. In section 3, an empirical strategy is proposed to shed light on the determinants of TFP in Ecuador, while section 4 shows the results of the estimation. Robustness checks are carried out in section 5 and the main conclusions of the article are summarized in section 6.

2.2. Overview of data and evolution of the economy

As pointed out above, Ecuador has performed better, on average, than the average of the largest Latin American countries during the period 1950–2014. Table 2.1 shows the annual average GDP per capita and per worker growth rates and the TFP growth rate for the largest countries of the region. Data on real GDP (in millions of USD 2011), population and employment were provided by the UC Davis and Groningen Growth and Development Centre's Penn World Table (PWT). As can be seen, the annual average GDP per capita and TFP growth rates of Ecuador are higher than the annual average growth rate of these countries. Looking across countries, Ecuador's growth rate is just below Chile and Brazil in terms of GDP per capita and per worker, and only below Brazil in terms of TFP. Most interestingly, considering the net oil exporter countries of the region, Ecuador's growth rate is the highest.

Figure 2.1 shows the evolution of the GDP per capita and per worker of Ecuador over the period 1950–2014 which are measured by the left-hand axis, while the evolution of the TFP index is measured by the right-hand axis. As can be observed, GDP per worker (per capita) and TFP follow a very similar trend, which could be

suggesting that economic growth in Ecuador is mostly driven by TFP. Figure 2.2 confirms our suspicion, since it shows that GPD growth rate volatility is mostly due to TFP volatility since the input growth rate is more stable during the 1950–2014 period. [4]

According to Figure 2.1, four phases of economic growth can be clearly distinguished in Ecuador. The period from 1950 to 1971, which can be called the "pre-oil boom" period. The period from 1972 to 1981 is characterized by the bonanza due to the first oil boom and was followed by the debt and financial crisis after the decrease in oil prices from 1982 to 1999. The last period started in 2000 when a major change in economic policy was introduced: the dollarization of the economy, which coincided with a second boom in oil prices.

2.2.1. Pre-oil boom period (1950–1971)

During this phase, banana was the main export product of the Ecuadorian economy. Banana plantations were mainly concentrated in the coastal regional and soon took over land used to cultivate other agricultural products, which remained only to supply domestic demand. The higher demand for labor in the banana plantations fostered migration from the Sierra to the Coast. According to Acosta (2006), since multinational companies were in charge of the production and trade of banana, an oligopoly was formed in the banana sector with negative consequences on the labor sector due to the reduction in the average wage of workers below the poverty line, which allowed these companies to gain competitiveness in the world market. During the 1950s and part of the 1960s, Ecuador became the main banana producer and exporter worldwide.

According to statistical information on international trade from the Central Bank of Ecuador (BCE, 2012), exports of traditional products, mostly agricultural products, accounted for at least 80% of total exports and banana exports accounted for approximately 40% of total exports during this phase.

In the 1950s, Ecuador joined its fellow regional countries in adopting the import-substituting industrialization model (ISI)[5,6] to boost the industrial sector following the

[4] In a study of the productivity of the Ecuadorian manufacturing sector, Camino-Mogro et al. (2018) found that productivity growth coincides with the growth of GDP.

[5] The ISI model was promoted by the Economic Commission for Latin America and the Caribbean (ECLAC/CEPAL), which was created in 1948 to foster and boost economic development in Latin American countries by protecting the industrial sector. The model aimed to follow the path of industrialized countries in order to tighten the technological gap.

ECLAC recommendations. The revenues brought by banana exports allowed priority economic sectors to be subsidized and social projects to be supported. As a result, the public sector started growing as well as the external debt[7] (Acosta, 2006). However, the ISI model would not be fully implemented until a military dictatorship took control of the country in 1963. The Military Junta started a reform of the Ecuadorian tax system in order to generate the necessary revenues to maintain the ISI model. According to Paz and Cepeda (2015), a progressive income tax policy was implemented under this tax reform, which aimed to favor the lower income classes. Moreover, the Single Taxpayer Registration was created in order to improve the collection of taxes on commercial transactions, a predecessor to the value-added tax,[8] and the unification of taxes on the trade of several import products. When the Military Junta regime came to an end in 1966, some of the reform policies had not yet been fully implemented.

During the first years of the ISI model, the main source of external revenues for Ecuador came from the banana exports that would later be replaced by oil exports. The revenues generated by these commodities allowed the government to invest in infrastructure.[9]

As a development strategy, the ISI model was intended to accelerate the process of structural change in Latin American countries, going from the agro-export model to industrialization by substituting the consumption of basic and non-durable imported goods by those produced domestically. Later, the substitution of capital goods would follow a similar path once the domestic industry had been able to absorb the necessary technology from imported capital goods, hence reducing the technological gap (Hirschman, 1968; Baer, 1972; Balassa, 1980). Government intervention was thought to be crucial to achieve successful results. However, as the governments tended to protect the bonanza sector through subsidies and protectionist policies, detrimental effects were produced on other economic sectors as a result of neglecting the comparative advantage theory (Balassa, 1980; Edwards, 1995). According to Baer (1972), the absence of an entrepreneurial class, a qualified workforce and the incapacity of the governments to cope with a prolonged industrial process did not permit the absorption of new

[6] Baer (1972) and Chang (2002), among others, argued that most of the current developed countries went through a stage of protectionism to develop their industries, especially in the late nineteenth century and the first decades of the twentieth century.
[7] In 1950, Ecuador's total external debt amounted to 24.5 million USD. By the year 1971, it had reached 260.8 million USD.
[8] It was not until the 1989 tax reform that the tax on commercial transactions started to be called value-added tax (VAT) and was applied to more products.
[9] Infrastructure to connect the Sierra and the Coast was significantly improved.

technologies. Moreover, Gerschenkron (1962) had already stated that the more backward a country that started its industrialization process, the less likely its agricultural sector would play any active role in the economic growth.

Despite the growth of industrial activity in Ecuador, there were few positive impacts on other economic sectors, which could be also related to the lack of coordination between sectors, the absence of a macroeconomic policy and political instability. Hirschman (1968) and Pinto (1970) warned about the protectionist policy by arguing that such a policy would end up preventing investors and businessmen from creating wealth, and make it difficult to reduce the technological gap. They also noted that for small economies, the success of protectionist policies is very limited. When the banana market started to show signs of exhaustion, the banana companies began to leave the country to settle in Central America in search of higher profits. The decrease in the prices of agricultural goods and especially the lower price of bananas caused the trade balance to go into deficit for most of the 1960s.

As can be seen in Table 2.2, Ecuador's GDP growth rate during this first stage was, on average, 4.91% annually, while GDP per capita and per worker showed an annual average growth of 1.95% and 2.61%, respectively. Moreover, the TFP index grew at an average annual rate of 1.81%. Acosta (2006) and Rodrigues (2010), among others, argued that this growth was caused by the dynamism of the recovery and growth of the world markets after the Second World War, as well as the action of certain social groups rather than as a result of the ISI model policy. However, this growth was not strong enough to cause a fundamental change in the productive structure of these countries. Moreover, it is often believed that there was not enough political interest to change the structure of the economy as Baer argued (1972). The first panel of Table 2.2 also shows that the inflation rate was low, the economy was fairly closed to international markets and the rate of illiteracy was high. However, the period shows the least inequality of the four. The evolution of the economic structure is shown in the second panel of Table 2.2.

2.2.2. First oil boom (1972–1981)

In 1972, large-scale oil exports began[10] in Ecuador, which was under another dictatorship regime that had taken control of the country in the early 1970s. In this period, Ecuador experienced a major change in the accumulation of wealth. The

[10] In 1964, the Texaco-Gulf partnership obtained a license to explore for oil in eastern Ecuador. The first oil well was drilled in 1967.

urbanization process in big cities was consolidated, a middle class emerged and the public sector expanded significantly as one out of three employees in urban areas was working in the public sector (Hofman, 1994; Acosta, 2006).

Ecuador joined OPEC in 1973,[11] becoming the second Latin American country to form part of the organization after Venezuela. Oil prices climbed by up to 300% from 1973 to 1974 and the Military Junta ordered by law the return of approximately 80% of concessions that foreign oil companies had previously obtained to explore for oil in the country. The law permitted the government to control oil production and trade, thus increasing revenues, which allowed it to fund funding important oil projects such as the Esmeraldas Refinery, the Ecuadorian State Petroleum Corporation and the Ecuadorian Petroleum Fleet, as well as basic infrastructure.

Economic growth rate was spectacularly high in 1972 (14%) and 1973 (25%); the highest levels reported in these six decades (see Figure 2.2). According to Central Bank of Ecuador's statistics, oil exports became the main component of total exports with almost 50% on average from this phase on and an important source of revenues for the public budget with a share of about 30% since the 1970s.

Strikingly, during the oil boom, the dictatorship incurred loans from international organizations to finance the increasing public spending. This easy access to credit would later lead to the debt crisis in Ecuador.

When Ecuador regained democracy in 1979, the ISI model was already in decline with disappointing results. While it is true that industrial activity increased, the dependency on imported inputs led to a high import ratio, making this policy inefficient to promote structural change in Ecuador. Moreover, according to Fontaine (2002), the oil sector caused a reduction in industrial and agricultural productivity in Ecuador which, along with the ISI model and its substitution effect, led to a progressive loss of competitiveness of non-export sectors and a "de-industrialization" process of the economy.

The ISI model was progressively abandoned in the late 1970s and early 1980s by Latin American countries due to its disappointing results, which led to the adoption of trade liberalization policies. Felix (1989) and Kay (2002) compared the implementation of the ISI model in both Latin America and Asian NICs[12] as these regions applied the

[11] In 1992, Ecuador voluntarily suspended its membership to OPEC. It resumed membership in 2007.
[12] "Newly industrialized countries" is a term applied to several countries whose economies have not yet reached the status of a developed country, but have outpaced their developing counterparts.

model after the mid-twentieth century and found that the paths taken by these regions were remarkably different for various reasons; one of them being the consumption behavior that allowed the Asian NICs to more quickly absorb the technology from capital-goods imports, while Latin American countries were unable to do so. Another was the agrarian reform. While agrarian reform in the Asian NICs came before any attempt at industrialization in Latin America, this reform started after the implementation of the ISI model. Prescott (1998) suggested that for some sectors of some countries there is a kind of resistance to adopt new technologies and use currently operating technologies efficiently.

De Gregorio (1992), Hofman (1994) and Astorga *et al*. (2005, 2011), among others, found that from 1950 until the mid-1970s Latin American countries in general showed a rapid TFP growth with little volatility. Indeed, it was thought that these countries were on the path to convergence with industrialized countries. Moreover, De Gregorio (1992) pointed out that Ecuador performed better than other Latin American countries due precisely to the bonanza experienced from the 1950s to the 1970s. After this period, however, the TFP growth rate began to decrease as can be seen in Figure 2.1 for Ecuador.

According to Naranjo (1995) and Ocampo (2005), the mismanagement of oil resources and increasing government intervention caused the Dutch disease or "the curse of natural resources" of the Ecuadorian economy. Gylfason (2001), Torvik (2001) among others who have studied the Dutch disease, argued that well-endowed countries with non-renewable natural resources, such as oil, find it difficult to grow and catch-up with developed countries due to the volatility of such foreign revenues. They also noted that these countries experience low economic growth because the sector in which the boom occurs is unable to produce a "learning by doing" effect due to the low education level and low investment in human capital. Moreover, Gelb (1988) suggested that Ecuador, Iran, Nigeria and Trinidad and Tobago suffered Dutch disease mainly due to a decline in the agriculture sector during the oil booms from 1972 to 1981.

According to Bulte *et al*. (2003), another characteristic of Dutch disease is that it drives public investment to non-productive and less technological sectors, thus preventing the pursuit of economic efficiency and causing a null "learning by doing" effect because the business class becomes dependent on the incentives and subsidies that the government provides.

As can be seen in Table 2.2, the oil boom boosted the country's economy. Ecuador's annual average GDP growth rate during this first phase was 8.83%, while GDP per capita and per worker grew, on average, 5.93% and 5.01% annually, respectively. Moreover, the annual average growth of TFP was 3.46%. However, the inflation rate reached two digits and inequality increased despite some social programs, such as alphabetization which did reduce the illiteracy rate.

2.2.3. Debt and financial crisis (1982–1999)

In the early 1980s a new democratic system was established and the reduction of government spending was one of the two main policies implemented to fulfill payment obligations of the external debt[13] incurred during the boom period. This was a critical period due to the tightening of monetary policies of the US and UK, which raised the interest rate and caused a crisis in global bond markets. The decline of export revenues due to the fall in commodities prices and the rising prices of import goods led to the deterioration of the external balance. Moreover, the deficit of the non-oil trade balance became more evident due to the high dependency of the manufacture sector on imports for production. Arcos (1990) pointed out that since industrial production in Ecuador was mostly targeted to the domestic market, the country's exports other than oil continued to be primary and hardly generated foreign inflows. Hence, external indebtedness acquired more relevance.

Under these circumstances, Ecuador adopted a trade liberalization policy. The promotion of exports was the main economic policy undertaken by the government to boost economic growth. Liberalization brought a large influx of foreign capital which, along with the austerity policy to reduce public spending, aimed to correct Ecuador's external and internal balances. According to Arteta (2000), such foreign inflows were mostly driven to fund consumption and for the accumulation of reserves. Moreover, the inflation rate started to grow disproportionately, which affected wages and domestic demand, the sucre (the domestic currency) began a process of continuous devaluation[14] and the weakness of the fiscal policy contributed to reducing government revenues, thus jeopardizing its capacity to pay the foreign debt.

[13] In the 1970s, the share of external debt did not exceed 20% of GDP. By the end of the 1990s, however, this share increased to 90% of GDP.

[14] Under the macroeconomic adjustment and stability policies, the government and the Central Bank of Ecuador established a scheme of controlled devaluations within exchange rate bands, which were adjusted consecutively until 1999.

The credit boom due to foreign capital flows led to a financial crisis in the late 1990s. Despite government intervention through a bank bailout, most of the country's largest banks went bankrupt and the Ecuadorian economy decreased 5% in 1999, per capita income decreased 3%, inflation rose to 52% and the sucre was devaluated about 210%. One of the consequences of this crisis was the loss of the sucre and the adoption of the US dollar as the national currency. Another consequence was the massive migration of Ecuadorians to other countries.

Although the GDP grew over this period, it exhibits the lowest annual average growth rate of the four periods. Moreover, GDP per capita and per worker growth rates were negative. TFP from this period onwards showed a decreasing trend and a negative annual average growth rate (see Figure 2.2 and Table 2.2) and the inflation rate worsened.

The 1990s may have been the most difficult decade for the Ecuadorian economy, not only as a result of the economic factors pointed out above, but also for other reasons such as a war with Peru in 1995, which involved a major expense for the government, and El Niño in 1997–1998, which caused millions of dollars in losses, especially in the country's infrastructure and agricultural sector.

2.2.4. Dollarization and the second oil boom (2000–2014)

In January 2000, the government decided to adopt the US dollar as the national currency to avoid the total collapse of the economy. However, this measure did not prevent at least one million people from leaving the country in the following years due to the lack of employment.[15] According to an International Labor Organization report (ILO, 2013), more than half of all Ecuadorians that left the country following the financial crisis were young people between the ages of 15 and 29 who were either working or studying.

Uncertainty and the political instability in the late twentieth century and early twenty-first century[16] sunk Ecuador into a severe economic crisis. Mauro (1995), Astorga *et al*. (2005) and Dixit (2009) argued that less developed countries usually suffer from political instability, weak governments, bureaucratic corruption and macroeconomic uncertainty, which lead to poor economic performance. According to Baumol *et al*. (2007), governments of Latin America, the Arab Middle East, Africa and most of the countries that belonged to the former Soviet Union tend to maintain and

[15] In 2000, Ecuador had a population of about 12 million inhabitants.
[16] Seven presidents (elected and interim) held office in the country from 1996 to 2006.

enhance the economic position of a small portion of the population, while economic growth is not a central objective.

Although dollarization prevented Ecuador from entering into a deep economic depression, it unveiled deficiencies in the production structure that the previous oil bonanza had disguised.

According to an Inter-American Development Bank report (IADB, 2008), migrant remittances[17] and the rising oil prices since 2005, among other factors, allowed the recovery of the economy at that time. However, the country's production structure remained weak, uncompetitive, undiversified and dependent on the oil sector, thus making it vulnerable to external and internal shocks.

Spurred on by the higher oil revenues, the government started implementing several social programs to reduce poverty and inequality in 2007. One of the main objectives of the government was to achieve the desired structural change, and in order to achieve such an objective, investment in public infrastructure became essential, especially in roads, power plants, education and health. In order to maintain such investments, the government assumed greater control over strategic sectors, which raised concern among private investors. Hall and Jones (1999) suggested that government interference in production will be unable to achieve levels of output per worker near the levels of rich countries. Dixit (2009) stated that government's failure to protect private property rights are major causes of poor economic performance in many countries, especially less developed countries.

During the global financial crisis of 2008–2009, migrant remittances decreased. However, the higher oil prices, as well as government policies such as the strengthening of the fiscal policy,[18] the renegotiation of external debt and substantial external financing, allowed Ecuador to achieve significant economic growth during this international crisis while most of its fellow regional partners did not.

According to statistical reports of the Central Bank of Ecuador (BCE, 2012), despite the fact that the Ecuadorian trade balance has been mostly positive in the first decade of the twenty-first century, the non-oil trade balance has been negative and the diversification of exportable supply has remained practically static over the years.

[17] Remittances from migrants accounted for 1.88% of GDP from 1991 to 1997 and increased to 6.40% of GDP from 1999 to 2005. From 2010 to 2014 remittances accounted for 3.03% of GDP.

[18] Data from the tax collection agency (*Servicio de Rentas Internas-SRI*) website: Average tax collection in the period 2001–2006 was 20.3 million of dollars. Average tax collection in the period 2007–2012 was 47.9 million dollars. The tax burden in 2001 was 11.2%, while it was 19.7% in 2014.

Moreover, the application of certain restrictions on imports to protect domestic industry has caused concern in the private sector.

As can be seen in Table 2.2, this period is marked by a recovery of the Ecuadorian economy. The country again found the growth path in terms of GDP. TFP is showing signs of reversing the negative trend, inflation and illiteracy rates have diminished notably, the economy is more open and inequality has begun to decrease.

2.3. Empirical Strategy

Let the economy produce according to a production function with neutral technical progress in Hicks' sense as follows

$$Y_t = A_t F(K_t, L_t)$$

Where *Y* is the output, *K* is the stock of physical capital, *L* is the numbers of workers and *A* is what Solow (1957) defined as "technological change" that we call TFP and collects the effects of variables other than inputs (*K* and *L*) on the output. Sub index *t* is the time period.

TFP is considered to be the main driver of GDP volatility, especially in middle-income countries, as found by Moro (2015). Therefore, in this section an econometric model to shed light on the determinants of TFP in Ecuador is proposed.

Let TFP evolve over time according to the following equation:

$$TFP_t = Z_t HC_t^{\beta_1} KMS_t^{\beta_2} FDI_t^{\beta_3} FER_t^{\beta_4} CI_t^{\beta_5} PI_t^{\beta_6} OIL_t^{\beta_7} \quad (1)$$

Equation (1) establishes a nonlinear relationship between the dependent variable and the independent variables which turn out to be a more plausible assumption than a linear specification that assumes constant marginal returns. Moreover, it allows interpreting the coefficients as elasticities.

Traditional variables that have been shown in the literature to affect TFP or GDP per capita growth have been introduced in equation (1).

Thus, *HC* is the human capital index based on years of schooling and returns to education as developed by Barro and Lee (2013) and provided by PWT. The seminal theoretical work of Romer (1990) showed that human capital has an important effect on *TFP* because of its role as a determinant of an economy's capacity to carry out technological innovation. Benhabib and Spiegel (1994) showed empirical evidence supporting Romer's theoretical results and suggested that the level of human capital

influences a country's capacity to develop its own technological innovations, which in turn is a determinant of TFP growth. Moreover, the empirical works of Becker *et al*. (1990), Barro (1991) and Hall and Jones (1999), among others, have demonstrated that high levels of investment in human capital have a positive impact on productivity.

KMS (kilometers per road built) is a proxy for the stock of public infrastructure provided by the Secretary of Public Works. The seminal work of Aschauer (1989) showed that public capital has a significant impact on productivity.[19]

FDI is the foreign direct investment (in millions of USD at 2011 constant prices) provided by the Central Bank of Ecuador. De Gregorio (1992) found a positive correlation between growth and FDI and suggested that it seems to be more efficient than domestic investment in Latin American countries. As pointed out by Isaksson (2007), FDI is viewed as a key channel for the transfer of advanced technology and superior organizational forms from industrialized to developing countries. Furthermore, FDI is believed to generate positive externalities in the form of knowledge spillovers to the domestic economy through, for instance, linkages with local suppliers and clients learning from nearby foreign firms and employee training programs.

FER is the fertility rate (children per woman) provided by the Statistics Institute of Ecuador (INEC). According to Becker et al. (1990) and Barro (1991), lower fertility rates mean more investment in human capital and economic growth. Moreover, they found that poorer countries tend to have higher fertility rates.

CI is a corruption index built by Dahlberg *et al*. (2017). The higher the CI index, the greater the corruption and vice versa. Political instability, weak institutional development and excessive bureaucratic rules lead to corruption, which is thought to affect long-run economic growth negatively (Barro, 1991; De Gregorio, 1992; Astorga *et al*., 2011).

PI is the consumer price index at 2011 base provided by the Central Bank of Ecuador. De Gregorio (1992) found a negative effect of inflation on growth in his sample for Latin American countries.

Because Ecuador is an oil exporting country and its economy largely depends on this resource, the variable *OIL*, which is the oil price in the international markets, is included and provided by the BP Statistical Review of World Energy.

The variable Z captures deterministic and random shocks in the Ecuadorian economy and is specified as follows

[19] For a survey of the effects of public capital on the economy, see Bom and Ligthart (2014).

$$Z_t = e^{(a_0 + a_1 D_t^{boom} + a_2 D_t^{crisis} + \alpha_3 D_t^{dol} + a_4 D_t^{ISI} + D_t^{soc} + \varepsilon_t)} \quad (2)$$

Where a_0 is the constant term, three dummies are included to control for the phases of economic growth described in section 2. Thus, D^{boom}, D^{crisis} and D^{dol} are the dummies for the first oil boom, the crisis period and the dollarization period.[20] Moreover, events which are suspected to have caused structural breaks are considered. Hence, D^{ISI} is a dummy capturing the import-substituting industrialization period (1952–1982) and D^{soc} is a dummy for the period of Rafael Correa's government (2007–2014). Finally, ε_t is a random disturbance.

Substituting equation (2) in (1) and taking the logarithm, the following linear specification is obtained:

$$\begin{aligned} \ln(TFP_t) = {} & \alpha_0 + a_1 D_t^{boom} + a_2 D_t^{crisis} + \alpha_3 D_t^{dol} + a_4 D_t^{ISI} + a_5 D_t^{soc} \\ & + \beta_1 \ln(HC_t) + \beta_2 \ln(KMS_t) + \beta_3 \ln(FDI_t) + \beta_4 \ln(FER_t) \\ & + \beta_5 \ln(CI_t) + \beta_6 \ln(PI_t) + \beta_7 \ln(OIL_t) + \varepsilon_t \end{aligned} \quad (3)$$

According to the literature, human capital, public infrastructure and foreign direct investment should have a positive impact on TFP. Therefore, $\beta_1, \beta_2, \beta_3 > 0$, while fertility rate, the corruption index and the price index are expected to be negatively related to TFP, that is, $\beta_4, \beta_5, \beta_6, < 0$. In addition, oil prices should be expected to have a positive effect on TFP, $\beta_7 > 0$.

Due to a lack of data, we try to reduce to the greatest possible extent the number of explanatory variables so that the parameters can be estimated with acceptable degrees of freedom. Therefore, variables considered in the literature as fostering economic growth, such as the openness index (exports+imports/GDP), have not been included. This is due to the fact that, in the case of Ecuador, such an indicator is highly correlated with commodity prices for the study period (0.8). Moreover, illiteracy rate (a variable that is frequently used in the literature) is not included since it is captured to a certain degree by the human capital index. In fact, these variables are negatively correlated (0.9). It has recently been argued that inequality has harmful effects on economic growth. However, data on the Gini coefficient are only available from 1960. In addition, banana price has not been included since data are also only available from 1960 in the Global Economic Monitoring of the World Bank. Moreover, the correlation coefficient with oil prices during the period 1960–2014 is 0.9.

[20] The dummy for the first phase is not included to avoid perfect multicollinearity.

Our specification is able to capture to a large extent the categories of variables proposed by Isaksson (2007) that have been found to affect TFP. Thus, HC captures the creation, transmission and absorption of knowledge, as well as education and training. FDI captures technology transfer and adoption. KMS accounts for infrastructure, CI for quality of institutions and FER for the social dimension. Structural changes are captured by the dummies. Moreover, as pointed out above, integration and trade are captured to some extent by oil prices.

2.4. Estimation Issues

The results of estimating equation (3) are shown in Table 2.3. OLS standard errors and standard errors corrected for heteroskedasticity *à la* White (1980) and for heteroskedasticity and autocorrelation *à la* Newey and West (1987) are also provided.

As expected, the human capital-TFP elasticity turned out to be positive and highly significant (1% level). As the economic literature has demonstrated, the accumulation of human capital is a prime factor for economic growth. Stock of human capital is mainly the result of investment in education. Investment in human capital can be thought as a strategy to enhance the absorptive capacity which in turn facilitates technology transfer. Figure 2.3 shows investment in education as a percentage of the GDP of Ecuador during the period analyzed.

The positive effect of infrastructure on TFP is once again confirmed. In particular, public infrastructure stock is supposed to enhance the productivity of private capital. The proxy used could be suggesting that public infrastructure stock, such as roads and highways, could reduce time and costs in transporting inputs and goods, and is thus beneficial for productivity gains and economic growth in Ecuador. Furthermore, it generally captures, to a certain degree, the total effect of transport infrastructure in the country (i.e., airports, ports, etc.) and on TFP. Public infrastructure stock is the result of public investment. Figure 2.4 shows public investment as a percentage of the GDP of Ecuador during the period analyzed. As can be seen, public investment as a ratio of GDP shows a similar trend to that of TFP in Figure 2.1, with the exception of the first boom period.

Contrary to some previous evidence, non-significant effect of foreign direct investment (FDI) on TFP is found which might have to do with the fact that FDI entering a country like Ecuador has aimed simply at making profits, while technology transfer has not been implied as Acosta (2006) suggested.

Unexpected signs are obtained for the coefficient of the political corruption index and the fertility rate, which turned out to be positive. However, they are not significant at any conventional level.

As expected, the elasticity between the price index and TFP is negative and significant at the 1% level. While it is true that sustainable economic growth entails an increase in the level of prices, this should be predictable for the economic agents who need information to make decisions. However, given that such increases occur in an unexpected manner, economic agents alter their consumption, savings and investment habits because they require a greater margin of error. As a result, the feeling of insecurity in the markets becomes latent and the performance of the economy is affected.

There is no doubt that oil prices have played an important role in Ecuador's economy since 1972. However, the estimation unveils that even though the effect of oil prices on TFP is positive, it is not robust enough. It is only significant at the 5% percent level with OLS standard errors, while it is not significant at any conventional level when standard errors are corrected for heteroskedasticity and autocorrelation. Since the oil industry has become the flagship product for the Ecuadorian economy and its revenues have allowed supporting major national projects, this result could be suggesting that the positive effects of oil prices on economic growth in Ecuador might accrue through the inputs of the production function rather than through TFP. Furthermore, oil prices could have an indirect effect on TFP through human capital and infrastructure since oil revenues fund investment in education and infrastructure. However, the results in Table 2.3 suggest that the first oil boom caused a positive and significant structural break on TFP, which could be explained by the fact that this event introduced a major change in the economic structure of Ecuador.

Strikingly, the crisis period caused a positive structural break. Although this result may seem odd, this period coincides with the liberalization of the economy. Liberalization typically stimulates competition, which becomes vital to increase TFP. Moreover, the liberalization policies, in general, come with a privatization program which facilitates market entry for new firms which are supposed to be more productive.

The period capturing dollarization of the economy and the second oil boom has not caused a structural break, which could indicate that losing control over monetary policy did not affect TFP or economic growth.

An interesting result is the effect caused by the ISI model during its implementation stage, which is positive and significant at the 1% level. This result may seem odd given the fact that the more closed a country's economy is, the lower the economic growth. However, it cannot be neglected that Ecuador was one of the few Latin American countries that experienced economic growth above the average of the region during the ISI model period. Moreover, this positive effect could have to do with the recovery and growth of the world markets after the Second World War as pointed out above (Acosta, 2006; Rodrigues, 2010). In contrast, the period of Rafael Correa's government seems to have had a significant and negative effect. This could be suggesting that some economic policies or institutional arrangements carried out during this period offset the positive effects of, for example, human capital and infrastructure.

Since human capital, infrastructure, CI and PI could be suspected to be simultaneously determined with TFP; Table 2.3 also shows the Wu-Hausman exogeneity test. A two-stage least squares (2SLS) regression was run using two lags of the variables suspected to be endogenous as instruments. As can be seen, the hypothesis of exogeneity of these variables cannot be rejected. The Sargan and Basmann tests show that the instruments are valid.

Table 2.3 also shows that the proposed model is able to explain 97% of the variability of the TFP and no concern of spurious regression arises since the Durbin-Watson (DW) is close to 2. Moreover, the Portmanteau test suggests that the residuals are white noise. Therefore, there could be a cointegration relationship between the dependent and independent variables. Due to the nature of economic series, it is possible that there are imbalances in the short term with respect to the long term. Thus, we estimate the error correction mechanism (ECM) to link the analysis of long-term equilibrium with the dynamics of short-term adjustment. Therefore, the following equation was estimated:

$$\begin{aligned}\Delta\ln(TFP_t) = {} & \tau_0 + \tau_1 D_t^{boom} + \tau_2 D_t^{crisis} + \tau_3 D_t^{dol} + \tau_4 D_t^{ISI} + \tau_5 D_t^{soc} + \theta_1 \Delta\ln(HC_t) \\ & + \theta_2 \Delta\ln(KMS_t) + \theta_3 \Delta\ln(FDI_t) + \theta_4 \Delta\ln(FER_t) + \theta_5 \Delta\ln(CI_t) + \theta_6 \Delta\ln(PI_t) \\ & + \theta_7 \Delta\ln(OIL_t) + \rho\hat{\varepsilon}_{t-1} + \mu_t \qquad (4)\end{aligned}$$

Where $\hat{\varepsilon}_{t-1}$are the lagged residuals of the estimation of equation (3).

Table 2.4 shows the results of estimating equation (4). The estimated coefficient of the lagged residuals has the expected sign and is significant at any conventional level. The Engle-Granger test suggests a stable relationship between the log of TFP and the

explanatory variables, that is, there is a common trend. Hence, the Engle-Granger ECM adjusts the short-term behavior of the log of TFP with its long-term behavior.

2.5. Robustness Check: Estimating Production Functions

Suppose that the economy produces according to a Cobb-Douglas production function with constant returns to scale as follows

$$Y_t = A_t K_t^{\gamma} L_t^{1-\gamma} \tag{5}$$

Where *Y* is the output determined by labor, *L*, stock of physical capital, *K*, and the level of technology or TFP, *A*. Data on labor and physical capital are from PWT. The coefficients γ and 1- γ measure the respective contribution of the inputs. Let us rewrite equation (4) in output per worker, y_t, so that we get

$$y_t = A_t {k_t}^{\gamma} \tag{6}$$

Where k_t is the stock of physical capital per worker.

Rewriting equation (6) in log, we obtain:

$$\ln(y_t) = \ln(A_t) + \gamma \ln(k_t) \tag{7}$$

Notice that $\ln(A_t) = \ln(TFP_t)$, therefore, substituting equation (3) in equation (7), the following expression is obtained:

$$\begin{aligned} \ln(y) = {} & \alpha_0 + a_1 D_t^{boom} + a_2 D_t^{crisis} + \alpha_3 D_t^{dol} + a_4 D_t^{ISI} + a_5 D_t^{soc} \\ & + \beta_1 \ln(HC_t) + \beta_2 \ln(KMS_t) + \beta_3 \ln(FDI_t) + \beta_4 \ln(FER_t) \\ & + \beta_5 \ln(CI_t) + \beta_6 \ln(PI_t) + \beta_7 \ln(OIL_t) + \gamma\, ln(K_t) + \varepsilon_t \end{aligned} \tag{8}$$

Table 2.5 shows the results of estimating equation (8) which are very similar to Table 2.3. It can be noticed that the variables that explain TFP can also explain output per worker. Strikingly, political corruption has a positive and significant effect, although weak, and oil price exhibits a stronger effect in this model. This might be suggesting that such variables could have direct positive effects on GDP per worker but no direct effects on TFP as found in the baseline model. In fact, the literature that has found positive effects of corruption on economic growth has used GDP per worker or per capita as explanatory variables. In general, the literature suggests that corruption is harmful for economic growth since it generates mistrust in the economic agents regarding the political system, thus discouraging investment. However, the early work

of Leff (1964) had already suggested that there are circumstances when corruption can be positive for economic growth. Recently, several works have analyzed corruption as a burden to economic growth and found evidence suggesting that corruption seems to be not only less harmful but have positive effects on the economy for some countries (Blackburn & Forgues-Puccio, 2009; Méon & Weill, 2010; Dzhumashev, 2014). According to this literature, institutional inefficiency, weak quality governance and excessive bureaucratic regulations can be overcome through corruption so that investors can obtain the necessary permits to operate in these markets, thus stimulating economic growth in these countries.

The main drawback to this kind of specification is the odd result regarding the stock of physical capital per worker whose estimated parameter turns out to be non-significant at any conventional level.

Alternatively, the following production function is proposed:

$$Y_t = A_t K_t^{\delta} (L_t H_t)^{1-\delta} \tag{9}$$

The interaction between human capital and labor $(L_t H_t)$ can be interpreted as an input capturing efficient labor. From equation (9) we obtain the output per efficient worker as follows:

$$\frac{Y_t}{L_t H_t} = \tilde{y}_t = A_t \tilde{k}_t^{\delta} \tag{10}$$

Where $\tilde{y}_t$and $\tilde{k}_t$ are output per efficient worker and stock of physical capital per efficient worker, respectively. Taking log in equation (10) we get

$$\ln(\tilde{y}_t) = \ln(A_t) + \delta \ln(\tilde{k}_t) \tag{11}$$

Equation (11) is estimated in a similar way as above. The results are shown in Table 2.6 and, as can be seen, are very similar to those presented in Tables 2.3 and 2.5.

2.6. Conclusions

This paper analyzes Ecuador's total factor productivity (TFP) and its possible determinants over the period 1950-2014. A nonlinear relationship between a TFP index and its potential determinant is proposed. Variables considered to be most relevant in explaining the TFP have been used.

In line with the literature that determines the sources of TFP growth, the empirical results obtained in this article show that human capital has played an important role in Ecuador's TFP, as well as public infrastructure. Furthermore, the results somewhat suggest that oil revenues positively affect Ecuador's economic growth through input accumulation rather than TFP. If oil prices have any effect on TFP, it might accrue indirectly through human capital and infrastructure. However, the first oil boom does seem to have caused a positive structural break on Ecuador's TFP. An interesting result is the positive effect of the ISI protectionist model on productivity since it is typically expected that the more closed a country is to the world, the worse its long-term economic performance. Along the same lines, the socialist government of Rafael Correa seems to have caused a negative structural break on TFP but no effect on GDP per worker is found. The results are robust to the estimation methods and the measure of TFP.

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Appendix 2.1 - Tables

Table 2.1

GDP per capita and per worker and TFP growth rates in selected Latin America countries, 1950–2014

Country	GDP per capita annual growth rate	GDP per worker annual growth rate	TFP annual growth rate
Ecuador	**2.12 (4.04)**	**1.67 (4.04)**	**0.70 (3.92)**
Seven largest LA countries	**1.68 (2.30)**	**1.39 (2.42)**	**0.09 (2.08)**
Argentina	1.25 (5.07)	1.08 (4.43)	0.06 (4.08)
Brazil	2.62 (3.61)	2.07 (3.77)	0.87 (3.38)
Chile	2.35 (4.83)	1.89 (4.08)	-0.08 (3.89)
Colombia	2.08 (2.23)	1.30 (2.24)	0.65 (1.98)
Mexico	1.85 (3.38)	1.20 (3.35)	0.07 (3.29)
Peru	1.62 (4.66)	1.08 (4.60)	-0.02 (4.27)
Venezuela	0.87 (5.31)	0.39 (4.75)	-0.53 (4.77)

Source: Author's calculations based on Penn World Table version 9.0 data

Table 2.2

Basic indicators for Ecuador, 1950–2014

Indicator/Stages	1950-1971 (pre oil-boom)	1972-1981 (1st oil-boom)	1982-1999 (debt and financial crisis)	2000-2014 (dollarization and 2nd oil-boom)
GDP[a]	4.91	8.83	2.11	4.48
GDP per capita[a]	1.95	5.93	-0.22	2.77
GDP per worker[a]	2.61	5.01	-1.07	1.61
Population[a]	2.88	2.73	2.34	1.67
TFP[b]	1.81	3.46	-1.33	-0.02
Inflation[c]	3.28	13.25	38.93	13.18
Openness[c]	0.30	0.31	0.41	0.57
GINI*[c]	0.41	0.60	0.47	0.50
Illiteracy[d]	33.18	19.51	12.05	7.48
Economic Structure	**1950-1971 (pre-oil boom)**	**1972-1981 (1st oil boom)**	**1982-1999 (debt and financial crisis)**	**2000-2014 (dollarization and 2nd oil boom)**
Agriculture*[e]	30.68	21.14	20.83	10.79
Industry*[e]	20.39	25.51	27.59	35.46
Services*[e]	48.93	53.34	51.58	53.75

Source: Central Bank of Ecuador, World Bank, ECLAC, United Nations.
Notes: *Data available since 1960; a) growth rate, average; b) annual growth, average; c) Index, annual average; d) as percent of population, average; e) share of GDP, annual average.

Table 2.3

Model 1: Determinants of TFP growth for Ecuador, 1950–2014

	Estimations			
	Coefficients	**OLS SE**	**White SE**	**Newey-West SE**
Constant	-2.4886	0.6202***	0.4663***	0.6001***
Human Capital	1.3037	0.2911***	0.2353***	0.2778***
Infrastructure-KMS	0.1115	0.0478**	0.0405***	0.0534**
FDI	0.0037	0.0075	0.0062	0.0065
Fertility	0.1030	0.1785	0.1201	0.1467
Corruption	0.0909	0.0678	0.0860	0.0742
Price Index	-0.0590	0.0113***	0.0104***	0.0120***
Oil Price	0.0371	0.0151**	0.0309	0.0231
Dummy Boom	0.1968	0.0268***	0.0655***	0.0458***
Dummy Crisis	0.1470	0.0441***	0.0709**	0.0549***
Dummy Dollar	0.0873	0.0574	0.1044	0.0862
Dummy ISI	0.0972	0.0212***	0.0122***	0.0126***
Dummy Socialist	-0.0710	0.0213***	0.0268**	0.0320**
R^2	0.9744			
DW	1.7849			
Portmanteau test	31.6207 *(0.3368)*			
Wu-Hausman	0.8368 *(0.5093)*			
Sargan	4.6843 *(0.3213)*			
Basmann	3.6599 *(0.4540)*			

Notes: Number of observations: 63. All variables in logs (except for dummies). P-values in italics.
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 2.4

Engle-Granger ECM

	Estimations	
	Coefficients	**OLS-SE**
Constant	0.0198	0.0266
Human Capital	-0.0850	1.9123
Infrastructure-KMS	0.0110	0.0635
FDI	-0.0003	0.0066
Fertility	0.1806	0.1504
Corruption	0.1616	0.0695
Price index	0.0990	0.0514
Oil price	-0.0012	0.0166
Dummy Boom	0.0202	0.0153
Dummy Crisis	-0.0599	0.0240**
Dummy Dollar	-0.0232	0.0253
Dummy ISI	-0.0022	0.0212
Dummy Socialist	0.0075	0.0200
Lagged residual	-0.8595	0.1409***
R^2	0.5834	
Engle-Granger(i)	|6.850|	

Notes: Number of observations: 60. All variables in logs (except dummies)
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.
(i): Critical values at: 1%: |6.353|; 5%: |5.625|; 10%: |5.264|

Table 2.5

Main determinants of GDP per worker growth for Ecuador, 1950–2014

		Estimations		
	Coefficients	**OLS SE**	**White SE**	**Newey-West SE**
Constant	4.5568	1.5332***	1.4027***	1.3847***
Human Capital	2.0660	0.2713***	0.2052***	0.2278***
Infrastructure-KMS	0.1168	0.0516**	0.0446**	0.0489**
FDI	-0.0004	0.0067	0.0055	0.0055
Fertility	0.0002	0.1746	0.1350	0.1678
Corruption	0.1017	0.0605*	0.0740	0.0532*
Price index	-0.0807	0.0123***	0.0115***	0.0128***
Oil price	0.0523	0.0146***	0.0300*	0.0195***
Dummy Boom	0.1741	0.0243***	0.0602***	0.0366***
Dummy Crisis	0.1169	0.0394***	0.0636*	0.0432***
Dummy Dollar	0.0810	0.0512	0.0890	0.0608
Dummy ISI	0.0933	0.0192***	0.0124***	0.0123***
Dummy Socialist	-0.0145	0.0238	0.0181	0.0176
Capital per worker	0.2149	0.1422	0.1345	0.1176*
R^2	0.9932			
DW	2.0752			
Portmanteau	26.3768	*(0.6053)*		
Wu-Hausman	0.8730	*(0.3550)*		
Sargan	0.2957	*(0.5866)*		
Basman	0.2241	*(0.6360)*		

Notes: Number of observations: 63. All variables are in logs (except dummies). *P*-values in italics.
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 2.6

Main determinants of GDP per efficient worker for Ecuador, 1950–2014

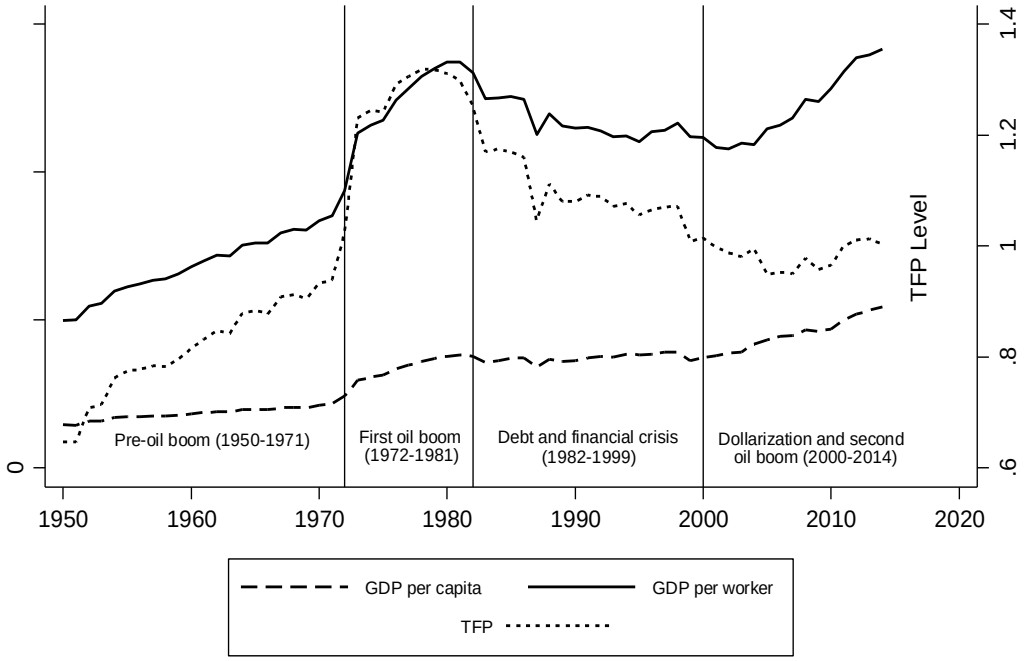
		Estimations		
	Coefficients	**OLS SE**	**White SE**	**Newey-West SE**
Constant	4.5555	1.5330***	1.3994***	1.3788***
Human Capital	1.2815	0.3417***	0.2878***	0.2905***
Infrastructure-KMS	0.1165	0.0516**	0.0445**	0.0487**
FDI	-0.0005	0.0067	0.0055	0.0055
Fertility	-0.0000	0.1746	0.1348	0.1675
Corruption	0.1015	0.0605*	0.0740	0.0532*
Price index	-0.0807	0.0123***	0.0114***	0.0127***
Oil price	0.0523	0.0146***	0.0301*	0.0195***
Dummy Boom	0.1741	0.0243***	0.0603***	0.0366***
Dummy Crisis	0.1168	0.0394***	0.0637*	0.0432***
Dummy Dollar	0.0808	0.0512	0.0891	0.0609
Dummy ISI	0.0933	0.0192***	0.0124***	0.0123***
Dummy Socialist	-0.0146	0.0238	0.0181	0.0175
Capital per efficient worker	0.2153	0.1421	0.1342	0.1169*
R^2	0.9818			
DW	2.0774			
Portmanteau	26.3581	*(0.6063)*		
Wu-Hausman	1.0206	*(0.3177)*		
Sargan	0.1290	*(0.7195)*		
Basmann	0.0974	*(0.7549)*		

Notes: Number of observations: 63. All variables in logs (except dummies). *P*-values in italics.
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Appendix 2.2 - Figures

Figure 2.1

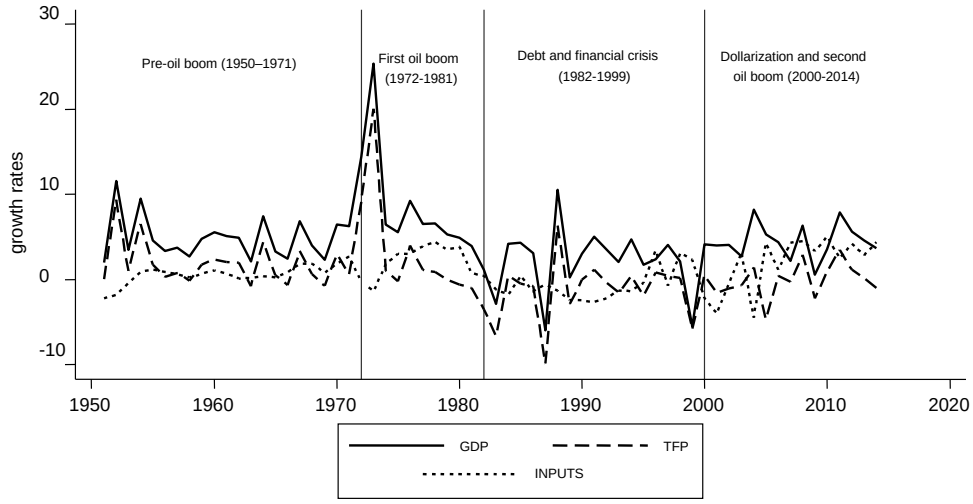
Real GDP per capita and per worker, and TFP index, Ecuador 1950-2014



Source: UC Davis and Groningen Growth Development Centre's Penn World Table.
Note: At constant 2011, national prices

Figure 2.2

Ecuador's growth rate of GDP, TFP and Inputs, 1950-2014



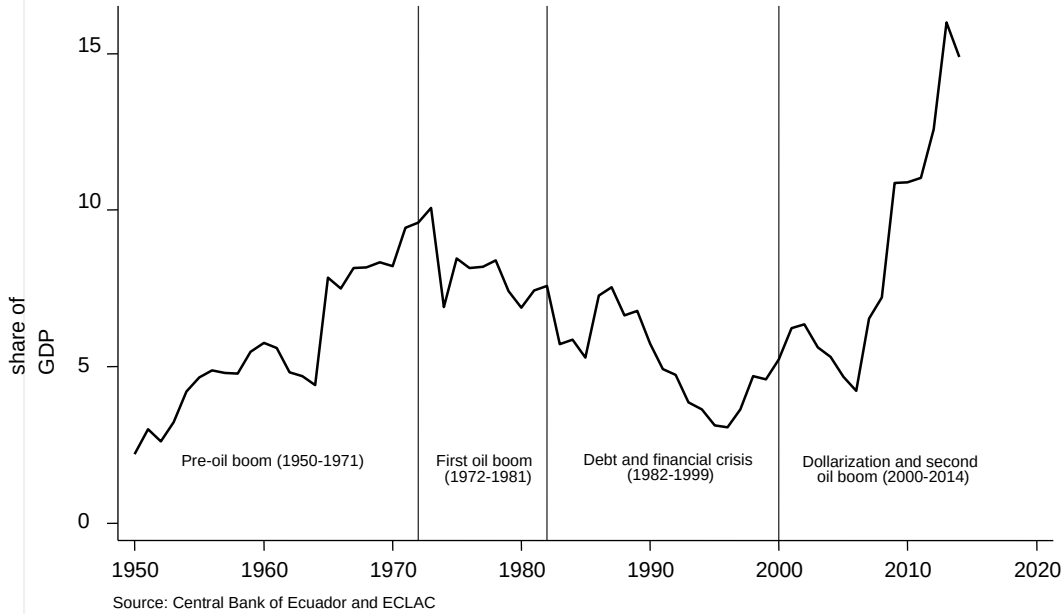
Source: Computations based on the UC Davis and Groningen Growth and Development Centre's Penn World Table.

Figure 2.3

Public expenditure on education, share of Ecuador's GDP, 1950-2014

Figure 2.4

Public investment, share of Ecuador's GDP, 1950-2014



Chapter 3
Public Investment Allocation across Ecuadorian provinces[21]

Abstract

We propose a theoretical framework which allows us to obtain a tractable equation for empirical implementation that relates the growth rate of public investment per capita by the central planner to variables typically associated with traditional public investment allocation criteria. Panel data for the Ecuadorian provinces over the period 2008–2015 are used. The results suggest that the central planner managed to deal with the traditional equity-efficiency trade-off, as well as the decongestion of some public services such as public transport and education. Additional evidence was also found that might raise suspicions regarding distributive politics.

Keywords: Public investment; equity-efficiency trade-off; political factors; Ecuador.

JEL classification: R58; H54

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3. Public Investment Allocation across Ecuadorian Provinces

3.1. Introduction

This article analyzes the allocation of public investment framed in the state's general budget across the Ecuadorian provinces for the period 2008–2015. The empirical strategy is based on a theoretical model in which the central planner maximizes a social welfare function to obtain optimal public investment at the provincial level. Moreover, in the process to allocate public investment across provinces, the central planner is assumed to have political incentives to deviate from the optimal investment levels. Based on the model, we obtain a tractable equation for empirical implementation, which relates the growth rate of public investment per capita of the central planner to variables that are typically associated in the literature with the traditional criteria for public investment allocation: efficiency, redistribution, special infrastructure needs and political factors. This article follows the same lines as De la Fuente and Vives (1995), Yamano and Ohkawara (2000), Castells and Solé-Ollé (2005), Cadot, Röller and Stephan (2006), Kemmerling and Stephan (2008), Agnani and Aray (2012), Monastiriotis and Psycharis (2014) and Aray (2019). Unlike our article, however, these references focused on developed countries. To the best of our knowledge, no articles in the relevant literature address this issue in any Latin American country with the exception of Costa-I-Font, Rodríguez-Oreggia and Lunapla (2003), Rodríguez-Oreggia and Rodríguez-Pose (2004) and Costa-I-Font and Rodríguez-Oreggia (2006), all of which focused on Mexico. Nonetheless, our approach is richer than theirs since the empirical strategy adopted here is based on a theoretical model.

The objective of this article is of particular interest to developing countries precisely because these countries have scarce public capital and theoretical and empirical studies have found a positive relationship between public capital stock and economic growth (Aschauer, 1989; Barro, 1990; Munnell and Cook, 1990; Lynde and Richmond, 1992; Glomm and Ravikumar, 1994, among others).

The case of Ecuador is especially striking because the country underwent significant changes during the government led by President Correa,[22] who implemented a national development plan called *Plan Nacional para el Buen Vivir* (National Plan for Good Living) in 2009 (SENPLADES, 2010).[23] The government claimed that this plan was an alternative to the traditional development policy and therefore constituted a change from the economic model in which the redistribution of income and wealth was paramount.

Ecuador is the eighth largest economy of Latin America and the fourth net oil exporting country in the region.[24] The exceptionally higher average oil prices during the period 2008–2015 provided the public sector with abundant financial resources to carry out important public investment projects in all provinces with the purpose of pursuing the objectives laid out in the *Buen Vivir* plan.

Data of the Economic Commission for Latin America and the Caribbean (ECLAC)[25] shows that during the period 2008–2015 the average share of public capital expenditures on the GDP by the central government in Ecuador (10.18%) was more than double the average of Latin America (4.34%) and about three times the average of the seven largest Latin American countries (3.29%) and the three largest net oil exporting countries of the region (3.57%). Moreover, Ecuador's annual average economic growth rate (3.75%) outperformed the average of the region (2.21%), the seven largest Latin American countries (2.06%) and the three largest net oil exporting Latin American countries (2.02%).[26] In per capita terms, economic growth shows a similar pattern.

In the empirical implementation, panel data on the provinces of Ecuador over the period 2008–2015 are used. It is not by chance that the sample period of this article coincides with the greater part of Correa's government (2007–2017). The reason is that under his mandate, there was a great push to collect regional statistics. That initiative has made this study possible. Accordingly, this article could be thought of as providing an evaluation of public investment allocation during Correa's government. The

[22] At the beginning of the 21st century, the political scenario in several Latin American countries radically changed as left-wing political parties achieved office. Ecuador was one of them when Rafael Correa took office in January 2007.

[23] National development plans are scheduled for 4 years: 2009–2013, 2013–2017, 2017–2021. The last one was renamed "*Toda una Vida*" by the new government.

[24] The seven largest Latin American economies are Brazil, Mexico, Argentina, Chile, Colombia, Venezuela and Peru. The three largest Latin American net oil exporting countries are Mexico, Venezuela and Colombia.

[25] https://estadisticas.cepal.org/cepalstat/Portada.html

[26] Ecuador grew less than Colombia but much more than Mexico and Venezuela.

empirical results show that there is a negative relationship between GDP per capita and the growth rate of public investment per capita, while this growth rate is positively related to an indicator of the productivity of the investment. This might suggest that the central government was able to cope with the traditional equity-efficiency trade off. In addition, significant correlations with some congestion indicators could be interpreted to mean that the central government devoted resources to decongest some public services such as public transport and education. Evidence on distributive politics was also found. In fact, a positive relationship between the growth rate of public investment per capita of the central planner and the share of provincial members of the national parliament (MPs) of Correa's party is found, and positive significant time effects prior to the election year raise suspicions about the use of public investment as a tool to serve his electoral campaign.

This article is organized as follows: the next section provides an overview of the main changes in public investment and revenues during the period considered. Section 3 provides the theoretical framework that supports the empirical strategy in Section 4. Data and estimations results are presented in section 5, while section 6 presents the robustness checks. Section 7 provides a discussion and conclusions are drawn in section 8.

3.2. A brief overview of changes in public revenues and public investment in the period 2008–2015

Ecuador's non-financial public sector (NFPS) has three types of revenues to finance public spending: permanent or non-oil revenues (mostly taxes), non-permanent or oil revenues and surplus from non-financial public companies. However, permanent and non-permanent revenues are the most prominent.

Article 286 of the Constitution of 2008 establishes that current expenses must be financed by permanent revenues to avoid uncertainties due to lack of liquidity, while capital expenditures must be funded through non-permanent revenues. Moreover, fiscal reforms aimed at changing the public revenue and expenditure dynamics were introduced in the period 2007–2010.

The level of tax evasion in the country was another issue to be tackled. It has been estimated that about 61% of the income tax and 32% of the value-added tax were evaded in 2004 and 2005 (SRI, 2012). Since fiscal policy became an important tool to

increase public revenues, the tax system was reformed to curb tax evasion. The renegotiation of the country's external debt was another major issue.

Data from the Central Bank of Ecuador[27] show that the NFPS' total annual revenues were, on average, 22.7% of GDP during the period 2000–2007, with permanent and non-permanent revenues amounting to 16.2% and 6.0% of GDP, respectively. During the period 2008–2015, these shares were 36%, 22.1% and 11.6%, respectively. The substantial growth of both types of revenues was due to the fiscal reforms and higher oil prices (SENPLADES, 2017). However, as can be noticed, the increase in the share of non-permanent (oil) revenues is striking. In fact, the annual average growth of the NFPS (central government's) oil revenues increased from around 2 (1.5) billion dollars between 2000–2007 to about 9.5 (4) billion dollars between 2008–2015 (nominal values).

In February 2007, the National Secretariat for Planning and Development (*Secretaría Nacional de Planificación y Desarrollo*, SENPLADES) was created by merging two former public institutions with the aim of promoting the country's integrated development at national and sector-wide levels. SENPLADES is attached to the executive branch of the government and is responsible for preparing the national development plan. This means that SENPLADES designs and determines the strategic policies and objectives regarding public investment and is, in effect, the "central planner."

The Constitution of 2008 strengthened the state's role in the provision of public goods and services. Article 280 establishes that the allocation of public investment and resources will be framed in the national development plan.

To redirect oil revenues to projects that boost the growth of the Ecuadorian provinces, as stated in the *Buen Vivir* plan, public sector institutions at all layers of government have the obligation to prepare annual investment projects.[28] It is mandatory for public institutions at all levels of government to implement these annual plans, in which priority is given to public investment projects (SENPLADES, 2017). [29]

Data from the Central Bank of Ecuador[30] reveal that the annual average share of public investment to total investment was 27.7% during the period 2000–2007 and rose

[27] Non-financial public sector operations: https://www.bce.fin.ec/index.php/component/k2/item/295-operaciones-del-sector-p%C3%BAblico-no-financiero.
[28] Art. 59 of the Organic Code on Planning and Public Finance (2010).
[29] Art. 60 of the Organic Code on Planning and Public Finance (2010).
[30] https://www.bce.fin.ec/index.php/component/k2/item/763

to 47.4% in the period 2008–2015. As a percentage of the GDP across the same time periods, it was 5.5% and 12.2%, respectively.

3.3. Theoretical model

The economy is composed of *J* provinces and the central planner has to allocate an amount of public funds (R_t) to public investment across the provinces in each period. Let us consider that provincial economy *j* produces an output, Y_{jt} in each period *t* according to a Cobb-Douglas production function as follows:

$$Y_{jt} = A_{jt} K_{jt}^{\mu_j} L_{jt}^{\phi_j} G_{jt}^{\theta_j} \qquad 0 < \mu_j, \phi_j, \theta_j < 1 \qquad (1)$$

Where K_{jt} is the non-residential private capital stock, L_{jt} is the labor input, G_{jt} is the public capital stock and A_{jt} is the total factor productivity. μ_j, ϕ_j, θ_j are the elasticities of the output with respect to the inputs. This is a production function in the spirit of the seminal work of Aschauer (1989), among others.

Following Hercowitz and Sampson (1991), Kocherlakota and Yi (1997) and Cassou and Lansing (1998), let G_{jt} accumulate according to the following law:[31]

$$G_{jt} = B_{jt} G_{jt-1}^{1-(\sigma_j+\vartheta_j)} I_{jt}^{\sigma_j} P_{jt}^{\vartheta_j} \qquad 0 < \sigma_j, \vartheta_j \leq 1\,; \quad 0 < \sigma_j + \vartheta_j \leq 1 \qquad (2)$$

Where I_{jt} (P_{jt}) is the public capital investment in province *j* in period *t* made by the central (subnational) government. σ_j and ϑ_j can be associated with the relative quality of old capital relative to new investment goods.[32] Cassou and Lansing (1998) pointed out that the advantage of the specification given by equation (2) with respect to the standard linear form is that the former exhibits decreasing returns, which can be interpreted as reflecting adjustment costs in increasing the volume of public capital stock or diminishing returns of the public investment. Moreover, as assumed by Hercowitz and Sampson (1991), capital accumulation is also subject to an exogenous shock, $B_{jt} > 0$.[33] B_{jt} , σ_j and ϑ_j govern the relationship between new investment and the next period's public capital stock. Thus, whenever $B_{jt} = 1$ and $\sigma_j + \vartheta_j = 1$, the stock of

[31] These authors used similar expressions to model the evolution of private capital stock.
[32] This is the type of capital-evolution equation used by Lucas and Prescott (1971).
[33] Hercowitz and Sampson (1991) assumed that B_{jt} is a random variable that depends on a stationary disturbance. However, as will be noticed below, considering B_{jt} as a random or deterministic shock has no implications for the estimations. In fact, we can assume $B_{jt} = 1$.

public capital depreciates fully after one period, while it is long lasting if $0 < \sigma_j + \vartheta_j < 1$.

According to Cassou and Lansing (1998), equation (2) might also be viewed as capturing the behavior of an aggregate stock that is measured by adding up different types of capital which individually display different depreciation characteristics. In this article, such an assumption is appropriate and is justified precisely because the public capital stock is composed of several types of infrastructures, including hard infrastructure stock (e.g., highways, roads, ports, airports, oil and power infrastructure, etc.) and soft infrastructure stock (e.g., the education system, the health system, knowledge development, institutional structures, innovation support, research and development, etc.).

In the spirit of Berhman and Craig (1987) and Castells and Solé-Ollé (2005), it is assumed that the central planner distributes public investment across provinces in order to maximize a social welfare function defined over the distribution of output among all the provinces. Therefore, a CES social welfare function (W_t) is specified that allows varying degrees of relative provincial inequality aversion as well as unequal treatment of provinces with the same output levels:

$$W_t = \left(\sum_{j=1}^{J} N_{jt} \Psi_{jt} y_{jt}^{\rho} \right)^{\frac{1}{\rho}} \qquad (3)$$

Where N_{jt} is the population and $y_{jt} = \frac{Y_{jt}}{N_{jt}}$ is the output per capita of province *j* in period *t*, $\rho \in (-\infty, 1]$ is the parameter that quantifies the aversion to regional output inequality. As ρ becomes more negative, inequality aversion increases. When $\rho \to -\infty$, the central government only concerns itself with equity. Conversely, if $\rho = 1$, the central government only concerns itself with the national output as a whole. The factors Ψ_{jt} relate to equal vs. unequal concern. If there is equal concern, $\Psi_{jt} = \Psi_t$ for all *J* provinces. This article considers that a benevolent central planner with unequal concern includes in Ψ_{jt} a province's economic, social and demographic variables and any other relevant characteristics, other than political factors. Ψ_{jt} can also be understood as a function that allows weighting the province (Berhman and Craig, 1987) and, as a result of considering the regions' special infrastructure needs, can deviate the central government investment from an investment allocation rule based strictly on the equity-

efficiency trade-off. Berhman and Craig (1987) and Castells and Solé-Ollé (2005) also suggested and introduced political factors in Ψ_{jt} to control for the political influence of the jurisdiction. As shown below, political factors are introduced in this model differently. Therefore, the objective of a benevolent central planner is to distribute the public investment across provinces so that maximizes equation (3) taking into account equations (1) and (2) and the budget constraint

$$\sum_{j=1}^{J} I_{jt} \leq \mathrm{R}_t \qquad (4)$$

The first order condition of the maximization problem is

$$\frac{\partial W_t}{\partial y_{jt}} \cdot \frac{\partial y_{jt}}{\partial G_{jt}} \cdot \frac{\partial G_{jt}}{\partial I_{jt}} - \lambda_t = 0 \quad \forall\, j, \qquad (5)$$

Where λ_t is the Lagrange multiplier, which can be interpreted as the marginal cost of public revenue.

Substituting partial derivatives in (5), the following equation is obtained

$$\left(\sum_{j=1}^{J} N_{jt}\Psi_{jt}y_{jt}^{\rho}\right)^{\frac{1-\rho}{\rho}} N_{jt}\Psi_{jt}y_{jt}^{\rho-1}\theta_j\sigma_j\frac{y_{jt}}{I_{jt}} - \lambda_t = 0 \quad \forall\, j,$$

The solution of this maximization problem provides the optimal level of public investment per capita in province *j* in year *t*, $\hat{\imath}_{jt} = \hat{I}_{jt}/N_{jt}$ such that

$$\hat{\imath}_{jt} = C\frac{\theta_j\sigma_j}{\lambda_t}\Psi_{jt}y_{jt}^{\rho-1}y_{jt} \qquad (6)$$

Where $C = \left(\sum_{j=1}^{J} N_{jt}\Psi_{jt}y_{jt}^{\rho}\right)^{\frac{1-\rho}{\rho}}$ is a constant positive term.

The fact that $\hat{\imath}_{jt}$ is the optimal level of public investment does not mean that it is made strictly. Therefore, let us consider a more realistic process to allocate public infrastructure investment taking into account that the central planner has political incentives to deviate from the optimal rule. Thus, consider that the per capita public investment made by the central planner in province *j* in year *t*, i_{jt}, adjusts toward the optimal level according to the following equation:

$$\frac{i_{jt}}{i_{jt-1}} = e^{(z_{jt}+\varepsilon_{jt})}\left(\frac{\hat{\imath}_{jt}}{i_{jt-1}}\right)^{\gamma}, \qquad 0 \leq \gamma \leq 1 \qquad (7)$$

Where parameter γ is the adjustment coefficient toward the optimal level of per capita public investment; Z_{jt} is an exogenous deterministic shock caused by political factors; ε_{jt} is a random disturbance with expected value, $E(\varepsilon_{jt}) = 0$; and e is the exponential operator. Taking the natural logarithm in equation (7), the growth rate of public investment per capita is obtained, which depends on the gap between the optimal level and the past level, political factors and the random disturbance.

$$\Delta Ln(i_{jt}) = Z_{jt} + \gamma Ln\left(\frac{\hat{\imath}_{jt}}{i_{jt-1}}\right) + \varepsilon_{jt} \qquad (8)$$

As pointed out by Castells and Solé-Ollé (2005), equation (8) suggests that adjusting public investment to its long-run value or optimal value entails costs. Additionally, whenever $Z_{jt} \neq 0$, the central planner favors or punishes regions based upon political considerations. Furthermore, in the extreme case of $\gamma = 1$, the expected value of the public investment per capita allocated to province j is $E[Ln(i_{jt})] = Z_{jt} + Ln(\hat{\imath}_{jt})$. That is, even though no adjustment costs are implied (immediate catch up), the expected public investment per capita will never achieve the optimal level because of political factors. In the case of $\gamma = 0$, $E[\Delta Ln(i_{jt})] = Z_{jt}$, that is, the expected value of the growth rate of public investment per capita depends exclusively on political factors.[34]

3.4. Empirical strategy

As suggested by Castells and Solé-Ollé (2005), the most recent information that the government has available to plan the allocation of public infrastructure is just from the previous period. For that reason, the variables considered in $\hat{\imath}_{jt}$ are expressed with one lag, such that equation (6) becomes

$$\hat{\imath}_{jt} = C\frac{\theta_j \sigma_j}{\lambda_t}\Psi_{jt-1} y_{jt-1}^{\rho-1} y_{jt-1} \qquad (9)$$

As pointed out by Aray (2019), this assumption is very common in the literature and has the additional advantage of avoiding endogeneity problems.

[34] The planning fallacy literature (Flyvbjerg, 2009 and Ansar, Flyvbjerg, Budzier and Lunn, 2016) might also explain the planner's deviation from the main objective and the pace to convergence to the optimal level. This literature has found evidence that most public projects worldwide incur in delays, which may be intentional or unintentional. Furthermore, it shows that the best projects are not necessarily implemented, but rather those that look best on paper, which typically have the largest cost underestimates and benefit overestimates and usually undervalue negative environmental and social impacts. However, with aggregate data it is difficult to test such a hypothesis.

Ψ_{jt-1} is constrained to the available information at provincial level on economic, social and demographic variables. Therefore, it collects variables intended to capture the special public capital needs of province j in period t-1, including hard and soft infrastructure needs. Thus, Ψ_{jt-1} is specified as follows:

$$\Psi_{jt-1} = \left(\frac{N_{jt-1}}{S_j}\right)^{\varphi_1}\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)^{\varphi_2}\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)^{\varphi_3}\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)^{\varphi_4}\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)^{\varphi_5} \quad (10)$$

$\frac{N_{jt-1}}{S_j}$ is the population density in province j in period $t-1$, where S_j is the surface area of province *j*. This variable is intended to capture the spatial concentration of social and economic activity (i.e., the so-called agglomeration), which in most cases comes with an intensive use of public infrastructure and services that produce congestion. Thus, two variables are proposed to capture the congestion of hard infrastructure: $\frac{V_{jt-1}}{Km_{jt-1}}$, which is the ratio between the number of registered vehicles in province j in year $t-1$ (V_{jt-1}) and the kilometers of roads built in province j in year $t-1$ (Km_{jt-1})[35] and $\frac{SE_{jt-1}}{N_{jt-1}}$, which is the public transport capacity and a proxy for the public transport capital, where SE_{jt-1} is the number of seats for passenger transportation in buses available in province j in year $t-1$. Moreover, two variables are included to capture the congestion of soft infrastructure: $\frac{ES_{jt-1}}{EI_{jt-1}}$, which is the ratio of students enrolled in primary and secondary schools (ES_{jt-1}) per school (EI_{jt-1}) in province j in period $t-1$; and $\frac{HB_{jt-1}}{N_{jt-1}}$, which is a proxy for public health capital, specifically the number of beds in hospitals (HB_{jt-1}) per capita in province j in period $t-1$.

Substituting equation (10) in equation (9), we obtain

$$\hat{\iota}_{jt} = C\frac{\theta_j\sigma_j}{\lambda_t}y_{jt-1}^{\rho-1}y_{jt-1}\left(\frac{N_{jt-1}}{S_j}\right)^{\varphi_1}\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)^{\varphi_2}\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)^{\varphi_3}\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)^{\varphi_4}\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)^{\varphi_5} \quad (11)$$

In the empirical implementation, Z_{jt} is specified as follows:

$$Z_{jt} = \alpha_1 PS_{jt} + \alpha_2 D_{jt}^{P} + \alpha_3 MV_{jt} + \alpha_4 MS_{jt} + \alpha_5 D_{jt}^{M} \quad (12)$$

Where PS_{jt} is the share of representatives in the central parliament (MPs) that belong to Correa's party in province j for the presidential period; D_{jt}^{P} is a dummy

[35] According to Fernald (1999), there is a notion that industrialized regions make intensive use of vehicles and roads, which causes congestion in the long run.

variable that takes the value of 1 if the prefect (the governor of the province) in province *j* belongs to Correa's party and 0 otherwise; MV_{jt} is the share of votes for the mayors in province *j* that belong to or are aligned with Correa's party; MS_{jt} is the share of mayors in province *j* that belong to or are aligned with Correa's party; and D_{jt}^{M} is a dummy variable that takes the value of 1 if the mayor of the capital of the province *j* belongs to Correa's party and 0 otherwise.

By substituting equations (11) and (12) in equation (8), the equation to be estimated is obtained: [36]

$$\Delta Ln(i_{jt}) = \delta + \delta_j + \tau_t + \gamma Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right) + \beta_1 Ln\left(y_{jt-1}\right) + \beta_2 Ln\left(\frac{N_{jt-1}}{S_j}\right) + \beta_3 Ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right) + \beta_4 Ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right) + \beta_5 Ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right) + \beta_6 Ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right) + \alpha_1 PS_{jt} + \alpha_2 D_{jt}^{P} + \alpha_3 MV_{jt} + \alpha_4 MS_{jt} + \alpha_5 D_{jt}^{M} + \varepsilon_{jt} \quad (13)$$

Where $\beta_1 = \gamma(\rho - 1)$, $\beta_h = \gamma\varphi_h$ for *h*=2,3,4,5,6. $\delta = \gamma Ln(C)$; δ_j is the individual effect that captures specific characteristic of province *j* that are invariant over time; and τ_t is the time effect which is common for all the provinces but variant over time and could capture the effects of the central planner's budget constraints, external and internal aggregated shocks and election years,[37] etc. The individual and time effects are embedded in $\gamma Ln\left(\frac{\theta_j \sigma_j}{\lambda_t}\right)$. Therefore, it can be noticed that $\delta_j = \gamma Ln(\theta_j \sigma_j)$ and $\tau_t = -\gamma Ln(\lambda_t)$.

Note that equation (13) allows capturing the traditional criteria proposed in the literature to allocate public investment: the efficiency criteria, the development/redistribution criteria, special public capital needs and political factors. Therefore, we test the following hypotheses:

H$_1$: ***The more productive the public investment, the greater the growth rate of public investment per capita***.

[36] The appendix shows that using a CES function with certain restrictions due to data availability produces the same equation

[37] Presidential elections were held in 2009 and 2013, while electoral provincial processes were held in 2009 and 2014. All provinces held electoral processes for the election of prefects and mayors in the same year.

To test this hypothesis, we have to focus on the efficiency criterion proxied by the variable $\frac{y_{jt-1}}{i_{jt-1}}$, which can be understood as a measure of the productivity of the public investment made by the central government in province j in year $t-1$. The literature suggests that the efficiency criterion is captured by $\frac{y_{jt-1}}{g_{jt-1}}$ (Kemmerling and Stephan, 2008; Aray, 2019), where g_{jt-1} is the public capital stock per capita. However, our specification was formulated so that we obtained $\frac{y_{jt-1}}{i_{jt-1}}$ since data on g_{jt} is not available. In fact, in this specification, since $0 \leq \gamma \leq 1$, a positive correlation between the growth rate of public investment per capita and our measure of public investment productivity is expected.

H2: ***The growth rate of public investment per capita is inversely related to the production per capita***

The development or redistributive criterion to allocate public investment is captured by $ln(y_{jt-1})$. It should be expected that $\beta_1 \leq 0$ since it is stated in the theoretical framework that $\rho \leq 1$ and $0 \leq \gamma \leq 1$. Thus, in our model, the growth rate of public investment per capita should be negatively correlated to the production per capita. This could suggest that in order to foster interregional convergence, lagging provinces should have, on average, higher growth rates of public investment per capita. In line with the theoretical model, notice that $\beta_1 = 0$ implies no concern about redistribution ($\rho = 1$).

Given that a fair allocation of public resources seeks to meet the well-known equity-efficiency trade-off, the central planner faces a dilemma, that is, to promote projects with a high economic impact and/or allocate infrastructure investment to reduce disparities.

H3: ***Special provincial characteristics influence the allocation of public investment***

If provincial characteristics (Ψ_{jt}) – which are captured by variables related to special capital needs – are found to influence the allocation of public investment, the hypothesis that all provinces are treated/weighted equally can be rejected. Intuition suggests that the growth rate of public investment should be higher in regions with more symptoms of agglomeration and congestion. Hence, for agglomeration and hard infrastructure congestion, it is reasonable to expect that $\beta_2, \beta_3 \geq 0$ and $\beta_4 \leq 0$. However, it could also be argued that isolated provinces, which are typically less

densely populated, and decongested provinces would require larger investments, not only to connect them more efficiently with major urban centers, but also to make them more attractive for private investment, which would suggest that $\beta_2, \beta_3 \leq 0$ and $\beta_4 \geq 0$. Therefore, the expected signs of agglomeration and hard infrastructure congestion variables turn out to be ambiguous. Regarding the variables that capture congestion in soft infrastructure, it is expected that $\beta_5 \geq 0$ and $\beta_6 \leq 0$ if the objective is to make a fair allocation of the investment in education and health.

H4: ***Political factors play a role when allocating public investment.***

According to the literature on distributive politics and pork barrel politics,[38] the composition of the national parliament and the political affiliation of different layers of government could deviate the allocation of public investment from objective criteria. The central planner could favor investment projects in politically aligned and supporting provinces (Cox and Mccubbins, 1986 and Grossman, 1994). Therefore, it is expected that $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5 \geq 0$. Nevertheless, a negative sign in any of those parameters could suggest that the central planner strategically allocates public investment in swing provinces to diminish the uncertainty of the electoral outcome (Lindbeck and Weibull, 1987; Dixit and Londregan, 1995, 1996, 1998).

3.5. Data and estimation results

Table 3.1 presents all the data and information sources used in this paper and Table 3.2 includes the main descriptive statistics of the variables used in the model for the 24 provinces of the country.[39] Table 3.3 shows the correlation between the variables of the model.

The results of estimating equation (13) are displayed in Table 3.4.[40] The structure of the panel is balanced. The Hausman test (H^{FR}) provides evidence in favor of the fixed effect method. Standard errors corrected for heteroskedasticity *à la* White (1980) are also provided, which we will refer to later. As can be seen, the model is able to explain around 60% of the variability of the dependent variable.

Table (3.4) shows that the efficiency criterion seems to have played an important role, since the estimated coefficient is positive and significant at the 1% level, thus suggesting that the growth rate of public investment per capita is positively correlated to the productivity of the investment measured as the ratio between output and public

[38] Rich (1989) summarizes the earlier prominent theories in the literature of distributive politics.
[39] Constant values for public investment expenditures were obtained using the GDP deflator.
[40] One provincial dummy and a one-time dummy were excluded to avoid perfect multicollinearity.

investment (H_1). Similarly, the criterion of regional development, or redistributive criterion, shows the expected sign and is also significant at the 1% level. The estimations show that the growth rate of public investment per capita is correlated negatively to the output per capita (H_2). This result might suggest that, in line with the *Buen Vivir* plan, the central planner has implemented a public investment policy aimed at fostering interprovincial convergence in output per capita in order to reduce regional disparities.

Despite having tried to capture the criterion of special public capital needs with several reasonable variables, most of the coefficients are not significant. The exceptions are transport capacity and the education indicator, which are significant at the 5% and 10% levels, respectively. Transport capacity is negatively correlated with the growth rate of public investment per capita, while, as expected, it is positively correlated with the ratio of students per school (H_3).

Finally, most coefficients of the variables that capture the political criterion turned out not to be significant at any conventional level of significance, except for α_1, which is significant at the 5% level and with the expected sign, suggesting a positive correlation between the growth rate of public investment per capita of the central planner and the share of provincial parliaments that belong to the party that holds office in the national government (H_4). This could be interpreted as if the central planner discriminates in favor of those provinces in which the central government has more support. Moreover, Table 3.4 shows the estimated time effects. During the period 2011–2014, oil prices were especially high and, as can be seen, the time effects are all positive during that period. Notably, however, the estimated coefficients for the years 2012 and 2013 are the only ones significant at the 5% and 10% levels, respectively. As mentioned above, presidential elections and provincial elections were held at the beginning of 2013 and 2014, respectively. These results might suggest that in the year prior to the presidential election in 2013, the growth rate of public investment per capita increased significantly and remained high during that year because of the anticipated provincial elections.[41]

Even though the empirical specification for $\hat{\iota}_{jt}$ allows avoiding most of the potential endogeneity problems, equation (13) might still suffer from an endogeneity

[41] No previous year effect is obtained for the provincial and local elections in 2009 because the estimation is for the period 2009–2015.

problem caused by the variable $Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$ since $Ln(i_{jt-1})$ is also on the left-hand side of the equation and is part of the dependent variable. Therefore, equation (13) was also estimated using two-stage least squares (2SLS). Table 3.4 shows the exogeneity tests of Hausman (H^E), which shows a negative statistic. However, the Davidson and MacKinnon exogeneity test (DM) shows the proper sign and does not suggest that the variable $Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$ is endogenous, while the Sargan test validates the use of the instruments.[42]

The results regarding efficiency and redistribution criteria might suggest that the central planner coped with the traditional equity-efficiency trade–off in order to achieve a balanced distribution of public investment across all Ecuador's provinces. Moreover, the significant coefficients for some variables that capture special public capital needs might also suggest that more agglomerated and congested provinces have been given priority. However, political factors seem to have also played a role.

The results found for Ecuador could be generalized or provide insights for other Latin American countries, especially for the largest Latin American net oil exporting countries. Thus, the fiscal reform, which established that capital expenditures were to be funded by oil revenues could be thought of as a way of ensuring a public infrastructure policy. Moreover, a balanced allocation of public investment that takes into account the efficiency, redistribution and specific public capital needs in those countries could be helpful in fostering economic growth in both the short and long run. For instance, public investment in hard infrastructure makes it easier and cheaper for firms to gain access to input supply and goods and service markets. This issue is interesting because poor public infrastructure stock in developing countries has been traditionally blamed for being one of the key factors that cause these countries to lag so far behind developed countries. In fact, the early work of Hirschman (1958) had already pointed out the need for an optimum balance between public infrastructure investment and private investment as a strategy to promote economic development. Moreover, public investment in education and health, as well as in R&D projects, can provide greater opportunities for individuals, thus increasing human capital and achieving a dual outcome: fostering economic growth and reducing inequality. Both of these outcomes

[42] The logs of the first and second lag of output per public investment made by the subnational governments in the provinces were used as instruments. Similar results are obtained with the log of the second and third lags of $Ln\left(\frac{y_{jt}}{i_{jt}}\right)$. In the latter case, however, one more year is lost.

are in line with the early results of Freeman (1967), who suggested that income redistribution requires selected projects that maximize net benefits and so increase national income and social welfare.

3.6. Robustness check

3.6.1. Variables measured by active population

We have already stated that literature on economic growth has shown theoretically and empirically that public capital and hence public investment foster economic growth. Models of economic growth usually measure variables per worker. However, data showing the number of workers for Ecuadorian provinces is not available. Therefore, we use the active population of the provinces as a proxy for the number of workers and the variables that were previously measured per capita are now measured by active population, which permits us to account for the provinces' economic potential. Table 3.5 shows the results. As can be seen, they are similar to Table 3.4.

3.6.2. Considering the investment made by the provincial governments

In the theoretical model the investment made by the subnational governments remains embedded in the output within the expression of optimal investment of the central planner and is considered implicitly in the empirical implementation with one lag. Therefore, in this subsection, a contemporaneous relationship between the growth rate of the per capita central planner's investment and the Log of the per capita investment made by the provincial governments, $Ln(p_{jt})$, is considered. This is because it is logically assumed that this variable is determined and known in the current period as a consequence of the elaboration of the budgets, which raise suspicions about its endogeneity. Moreover, the coefficient of this variable can be positive, negative or zero depending on its type of relationship to the central planner's public investment. Thus, a positive sign means that both investments are complementary, a negative sign implies a substitution relationship, while a zero value indicates they are independent. Table 3.6 shows that neither H^E nor DM provides evidence of the endogeneity of $Ln(p_{jt})$ and the Sargan test suggests that the instruments are valid.[43] Therefore, OLS estimations with robust standards are provided and the variable is measured per capita and per active

[43] The log of the first and second lags of $Ln(p_{jt})$ were used as instruments in the 2SLS regressions.

population. The coefficient of $Ln(p_{jt})$ is not significant at any conventional level and estimates for the remaining variables are similar to the previous cases.[44]

3.7. Discussion

According to the World Economic Forum's (WEF) *Global Competitiveness Report* (GCR), Ecuador moved from position 84 in the 2006–2007 report (WEF, 2006) to position 49 in the 2017–2018 report (WEF, 2018) in the ranking of overall infrastructure quality.

Moreover, economic indicators seem to indicate that the central government was on track in pursuit of the main objectives in the *Buen Vivir* plan. Data from the Central Bank of Ecuador show that the average annual growth rate of the economy in the period 2007–2015 was about 4.1%, public spending being the main driver. Moreover, World Bank data[45] show a reduction in poverty and inequality at the national level during the period under consideration. However, this trend had started in the early 2000s. In fact, during the period 2000–2006 the annual average growth rate of the economy was even higher, at 4.8%, and in contrast to the former period, the main driver was the private sector. Rinne and Sánchez-Páramo (2008) already pointed out that poverty rates, which had increased sharply during the crisis in the late 1990s, fell back to pre-crisis levels by 2006. Moreover, data elaborated by the Central Bank of Ecuador[46] indicate that there are still huge disparities both between and within provinces in 2017. For example, the oil-producing province of Orellana has a value added per capita about 10 times that of Zamora Chinchipe. Nevertheless, Orellana has an income poverty rate of 41%, while the rate for Zamora Chinchipe is 32.8%. In Pichincha and Guayas, the largest provinces, 9.6% and 15.3% of people live in poverty, respectively, while the same figure is 49.1%, 47.1% and 42.0% for Napo, Morona Santiago and Esmeralda, respectively.

In addition, World Bank data show an increase in total expenditure in education as a percentage of the GDP over the period under consideration. The GCR's general ranking of higher education quality (secondary and tertiary education)[47] also shows that Ecuador moved from position 119 in 2006–2007 (WEF, 2006) to position 86 in 2017–2018 (WEF, 2018). However, the World Bank *Systematic Country Diagnostic* (SCD, 2018) for Ecuador underlined that investment in education, although helping to improve

[44] Estimations with the growth rate of p_{jt} yielded similar results, which are available upon request.
[45] https://data.worldbank.org/
[46] Regional Accounts: https://www.bce.fin.ec/index.php/component/k2/item/293-cuentas-provinciales/
[47] This ranking refers to how well the educational system meets the needs of a competitive economy.

access and the quality of education outcomes, has had a limited impact on worker productivity. In terms of health infrastructure, the SCD reported that the Ministry of Health invested heavily in new and renovated hospitals in the period 2009–2015. The SCD also reports own estimations in investment in new or renovated hospitals between 2013 and 2018 of around US$1.36 billion and stated that this hospital construction has not yet resulted in an increase in availability of hospital beds nor a rise in hospital discharges due to delays in starting operations. In line with this, the GCR shows that Ecuador has maintained a stable position in the health indicator ranking for the period considered, occupying position 73 in the 2017–2018 report.

According to the empirical evidence shown in this article and the reports referred to above, it seems that public capital accumulation has been more noticeable in hard infrastructure. Moreover, public spending efficiency did not improve over this period, since Ecuador occupied position 122 in the 2006–2007 GCR report, while it ranked 127 in the 2017–2018 report.

Finally, the indicators of the rankings reported above are included in the computation of the Global Competitiveness Index (GCI), which shows that Ecuador has performed badly in terms of competitiveness, as it dropped from position 90 in the 2006–2007 report to position 97 in the 2017–2018 report.

3.8. Concluding Remarks

This article analyzed public investment allocation by the central government of Ecuador across the country's provinces for the period 2008–2015. A theoretical model of public resource allocation was proposed, which allowed a tractable equation to be estimated that can capture the traditional criteria stated in the literature: the equity-efficiency trade-off, special public capital needs and political factors.

The empirical results show strong evidence in favor of the equity-efficiency trade-off. A positive (negative) relationship between the growth rate of public investment per capita and an efficiency indicator (output per capita) was found. This result might suggest that the central government has favored lagging provinces while not neglecting more productive ones. In addition, there is a negative correlation between the transportation capacity indicator (number of seats on buses per capita) and the growth rate of the central planner's public investment, while it is positively correlated with the number of students per schools. These results could suggest that the central planner's public investment has tried to decongest public services such as public

transport and education. Political factors also seem to have played a role. The estimations show that the growth rate of the central government's public investment per capita is positively correlated with the share of provincial MPs that belong to the ruling party. Additionally, statistically significant time effects raise suspicious about the increase in the growth rate of public investment per capita in years prior to national or subnational elections. The estimation results are robust to several specifications.

Finally, a discussion is provided, which might shed light on policy implications regarding public spending efficiency in Ecuador during the period considered.

An interesting topic to be addressed in future research is the decentralization of the provinces and the criteria for the allocation of resources that the subnational governments have employed, especially when the central government has had a stronger say in public spending decisions. Another issue that would be worth analyzing is the convergence in output per capita across the provinces and the impact of economic policies on the country's productive structure, since, according to the *Buen Vivir* plan, public investment in recent years has been aimed not only at creating infrastructure and reducing social inequalities, but also at changing the productive model and mono-exporting nature of Ecuador's economy.

Appendix. CES production function

Let us consider a CES production function as follows:

$$Y_{jt} = \left(a_{Kj}K_{jt}^{\omega_j} + a_{Lj}L_{jt}^{\omega_j} + a_{Gj}G_{jt}^{\omega_j}\right)^{\frac{1}{\omega_j}} \qquad (A.1)$$

Where $\omega_j \in (-\infty, 1]$ is the substitution parameter, a_{Kj}, a_{Lj} and a_{Gj} are the share parameters and G_{jt} is given by equation (2). The CES function is more flexible and appropriate in the sense that the Cobb-Douglas specification is one of its limiting cases ($\omega = 0$).

The maximization of welfare function (3) subject to equations (A.1) and (2) and the resource constraint (4) produces

$$\left(\sum_{j=1}^{J} N_{jt}\Psi_{jt}y_{jt}^{\rho}\right)^{\frac{1-\rho}{\rho}} \frac{N_{jt}\Psi_{jt}y_{jt}^{\rho} \cdot Y_{jt}^{-\omega}a_{Gj}\sigma_j G_{jt}^{\omega}}{I_{jt}} - \lambda_t = 0 \quad \forall\, j,$$

and it is obtained that

$$\hat{\imath}_{jt} = C\,\frac{a_{Gj}\sigma_j}{\lambda_t}\Psi_{jt}y_{jt}^{\rho}\left(\frac{G_{jt}}{Y_{jt}}\right)^{\omega} \qquad (A.2)$$

As Berhman and Craig (1987) and Castells and Solé-Ollé (2005), let us also consider that political factors ($e^{Z_{jt}}$) are included in Ψ_{jt}. In fact, Castells and Solé-Ollé (2005) claimed that the most straightforward interpretation of Ψ_{jt} is to consider that it captures political considerations that make a region attractive enough to the central government to justify a deviation from the equity-efficiency rule. Therefore,

$$\Psi_{jt} = e^{Z_{jt}}\left(\frac{N_{jt-1}}{S_j}\right)^{\varphi_1}\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)^{\varphi_2}\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)^{\varphi_3}\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)^{\varphi_4}\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)^{\varphi_5} \qquad (A.3)$$

Let us now consider the following catch-up equation:

$$\frac{i_{jt}}{i_{jt-1}} = e^{\varepsilon_{jt}}\left(\frac{\hat{\imath}_{jt}}{i_{jt-1}}\right)^{\pi}, \qquad 0 \leq \pi \leq 1 \qquad (A.4)$$

Taking the natural logarithm in equation (A.4), substituting equations (A.2) and (A.3) and considering one lag on $y_{it}$and $\frac{G_{jt}}{Y_{jt}}$, the following equation is obtained:

$$\Delta Ln(i_{jt}) = \delta + \delta_j + \tau_t + \pi Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right) + \pi\omega Ln\left(\frac{G_{jt-1}}{Y_{jt-1}}\right) + \beta_1 Ln\left(y_{jt-1}\right) + \beta_2 Ln\left(\frac{N_{jt-1}}{S_j}\right) + \beta_3 Ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right) + \beta_4 Ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right) + \beta_5 Ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right) + \beta_6 Ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right) + \tilde{\alpha}_1 PS_{jt} + \tilde{\alpha}_2 D_{jt}^{P} + \tilde{\alpha}_3 MV_{jt} + \tilde{\alpha}_4 MS_{jt} + \tilde{\alpha}_5 D_{jt}^{M} + \varepsilon_{jt} \quad (A.5)$$

The drawback of equation is that data on G_{jt} are not available. If we consider $\frac{y_{jt-1}}{i_{jt-1}}$ as a proxy for $\frac{Y_{jt-1}}{G_{jt-1}}$, equation (A.5) equals equation (13):

$$\Delta Ln(i_{jt}) = \delta + \delta_j + \tau_t + \gamma Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right) + \beta_1 Ln\left(y_{jt-1}\right) + \beta_2 Ln\left(\frac{N_{jt-1}}{S_j}\right) + \beta_3 Ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right) + \beta_4 Ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right) + \beta_5 Ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right) + \beta_6 Ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right) + \tilde{\alpha}_1 PS_{jt} + \tilde{\alpha}_2 D_{jt}^{P} + \tilde{\alpha}_3 MV_{jt} + \tilde{\alpha}_4 MS_{jt} + \tilde{\alpha}_5 D_{jt}^{M} + \varepsilon_{jt} \quad (A.6)$$

Where $\gamma = \pi(1-\omega), \beta_1 = \pi(\rho - 1)$, $\beta_h = \pi\varphi_h$ for h=2,3,4,5,6, $\tilde{\alpha}_f = \pi\alpha_f$ for f=1,2,3,4,5, $\delta = \pi Ln(C), \delta_j = \pi Ln(a_{Gj}\sigma_j)$ and $\tau_t = -\pi Ln(\lambda_t)$.

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Appendix 3.1 - Tables

Table 3.1.

Definition of the variables and sources of statistics

Variable	*Definition*	*Source*
i_{jt}	Public investment per capita, made by the central government in province *j* in year *t*, in US dollars. Includes all sources of financing, excludes capital not tied to the project. Base year 2007.	Ministry of Economy and Finance and National Secretariat for Planning and Development (SENPLADES)
y_{jt}	Gross value-added per capita in province *j* in year *t*, in US dollars. Base year 2007.	Central Bank of Ecuador
p_{jt}	Capital expenditure per capita of subnational governments in province *j* in year *t*, in US dollars. Includes gross fixed capital formation. Base year 2007.	Central Bank of Ecuador and Ministry of Economy and Finance.
N_{jt}	Population of province *j* in year *t*.	National Institute of Statistics and Census (INEC)
S_j	Total area of province *j*, in square km	National Institute of Statistics and Census (INEC)
V_{jt}	Number of registered vehicles in province *j* in year *t*.	National Institute of Statistics and Census (INEC)
km_{jt}	Kilometers of road in province *j* in year *t*. Includes the state, provincial and cantonal road network.	Ministry of Public Works, provincial government databases.
SE_{jt}	Seating capacity of passenger transportation in province *j* in year *t*.	National Institute of Statistics and Census (INEC).
ES_{jt}	Number of students enrolled in primary and secondary schools in province *j* in year *t*. Includes public and private system.	Ministry of Education.
EI_{jt}	Number of primary and secondary education establishments in province *j* in year *t*. Includes public and private system.	Ministry of Education.

HB_{jt}	Number of beds in hospitals in province *j* in year *t*.	National Institute of Statistics and Census (INEC)
PS_{jt}	Share of representatives in the central parliament that belong to Correa's party in province j during the presidency.	National Electoral Council (CNE)
D_{jt}^{P}	Dummy variable that takes the value of 1 if the prefect (the governor of the province) in province *j* belongs to Correa's party and 0 otherwise.	National Electoral Council (CNE)
MV_{jt}	Share of votes for mayors in province j that belong to or are aligned with Correa's party.	National Electoral Council (CNE)
MS_{jt}	Share of mayors in province *j* that belong to or are aligned with Correa's party.	National Electoral Council (CNE)
D_{jt}^{M}	Dummy variable that takes the value of 1 if the mayor of the capital of province *j* belongs to Correa's party and 0 otherwise.	National Electoral Council (CNE)

Table 3.2.

Descriptive statistics for the main variables by provinces

Provinces	*stats*	$ln(i_{jt})$	$ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$	$ln(y_{jt-1})$	$ln\left(\frac{N_{jt-1}}{S_j}\right)$	$ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)$	$ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)$	$ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)$	$ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)$
Azuay	*Mean*	0.1654	2.5954	8.2117	4.5022	3.3135	-0.8980	5.2329	7.2027
	(SD)	(0.4060)	(0.4495)	(0.0504)	(0.0447)	(0.1258)	(0.0937)	(0.0696)	(0.0586)
Bolivar	*Mean*	0.0519	1.7187	7.3836	3.8883	1.3017	-1.8472	4.3755	5.1493
	(SD)	(0.4872)	(0.3432)	(0.0446)	(0.0293)	(0.2038)	(0.2639)	(0.0984)	(0.1069)
Cañar	*Mean*	0.1955	2.2579	7.7939	4.3328	3.0089	-1.0808	4.8349	5.6468
	(SD)	(0.2568)	(0.5054)	(0.0820)	(0.0429)	(0.2084)	(0.2834)	(0.1393)	(0.0515)
Carchi	*Mean*	0.1183	2.0605	7.7340	3.8204	2.0424	-1.2447	4.8694	5.1790
	(SD)	(0.2363)	(0.2723)	(0.0729)	(0.0278)	(0.1244)	(0.1968)	(0.2212)	(0.1809)
Chimborazo	*Mean*	-0.0175	2.2618	7.5982	4.2984	2.9251	-1.4238	4.4993	6.4352
	(SD)	(0.2972)	(0.1148)	(0.0753)	(0.0304)	(0.4157)	(0.2048)	(0.2303)	(0.0845)
Cotopaxi	*Mean*	0.1593	2.3238	7.7485	4.2511	3.0574	-1.4078	4.9928	6.0801
	(SD)	(0.4805)	(0.5845)	(0.0655)	(0.0385)	(0.3858)	(0.2727)	(0.0832)	(0.0881)
El Oro	*Mean*	0.0763	2.5915	8.0256	4.6952	2.7171	-1.7243	5.3009	6.8881
	(SD)	(0.4170)	(0.4058)	(0.0910)	(0.0375)	(0.2238)	(0.3515)	(0.1123)	(0.0797)
Esmeraldas	*Mean*	0.0569	2.3563	7.9039	3.5427	2.5155	-2.3194	4.9081	6.1096
	(SD)	(0.5511)	(0.4624)	(0.1161)	(0.0439)	(0.6872)	(0.5175)	(0.1544)	(0.4204)
Galapagos	*Mean*	-0.1445	1.7269	8.6286	1.1918	1.1852	-3.0749	5.4971	3.4001
	(SD)	(0.1918)	(0.0835)	(0.1548)	(0.0638)	(0.4526)	(0.6082)	(0.1462)	(0.0501)
Guayas	*Mean*	0.1630	3.3990	8.2522	5.5108	4.1148	-1.2446	5.3499	8.8040
	(SD)	(0.2727)	(0.4462)	(0.0627)	(0.0402)	(0.1243)	(0.2224)	(0.1997)	(0.0526)
Imbabura	*Mean*	0.1555	2.5695	7.8693	4.5111	3.2754	-1.1566	5.2775	6.2186
	(SD)	(0.2410)	(0.3372)	(0.1353)	(0.0378)	(0.2216)	(0.2130)	(0.2187)	(0.1126)
Loja	*Mean*	0.0708	2.1992	7.7457	3.7505	1.8990	-1.5895	4.4964	6.6746
	(SD)	(0.3252)	(0.2468)	(0.0695)	(0.0320)	(0.1574)	(0.2367)	(0.0733)	(0.0411)
Los Rios	*Mean*	0.0837	2.5116	7.8073	4.7248	2.7666	-1.9157	4.8057	7.0448
	(SD)	(0.3076)	(0.3377)	(0.0654)	(0.0384)	(0.1573)	(0.2262)	(0.1232)	(0.0765)
Manabi	*Mean*	0.0139	2.1944	7.7536	4.3213	2.8327	-1.7612	4.6360	7.6088
	(SD)	(0.2366)	(0.1739)	(0.0874)	(0.0309)	(0.3957)	(0.3772)	(0.1191)	(0.2617)
Morona Santiago	*Mean*	0.0141	0.9052	7.4305	1.8741	1.0183	-2.5457	4.2665	5.2091
	(SD)	(0.4171)	(0.1969)	(0.0830)	(0.0624)	(0.2683)	(0.4551)	(0.0976)	(0.1789)
Napo	*Mean*	0.2036	0.6212	7.7021	2.1603	0.8223	-2.3770	4.6066	5.1724
	(SD)	(0.5711)	(0.9722)	(0.2221)	(0.0572)	(0.3334)	(0.3211)	(0.0809)	(0.1763)

Orellana	*Mean*	-0.0566	4.3059	10.3694	1.8547	1.9410	-2.3295	4.5386	4.6859
	(SD)	(0.2207)	(0.2795)	(0.3234)	(0.0609)	(1.0247)	(0.4993)	(0.1303)	(0.1692)
Pastaza	*Mean*	-0.1128	2.7891	8.8825	1.0941	2.0646	-1.5778	4.3099	4.7591
	(SD)	(0.2506)	(0.3203)	(0.2327)	(0.0679)	(0.2977)	(0.2744)	(0.1337)	(0.1675)
Pichincha	*Mean*	0.1050	3.2036	8.5786	5.6487	4.4461	-0.8086	5.5859	8.5345
	(SD)	(0.3869)	(0.4417)	(0.0898)	(0.0488)	(0.2223)	(0.1850)	(0.1552)	(0.0578)
Santa Elena	*Mean*	0.0420	2.5296	7.9235	4.4755	2.7156	-2.4093	5.5663	5.3894
	(SD)	(0.3881)	(0.4600)	(0.1157)	(0.0583)	(0.3876)	(0.4629)	(0.1325)	(0.5516)
Santo Domingo	*Mean*	0.0812	2.6183	7.8654	4.7145	2.7729	-1.6479	5.2825	6.4048
	(SD)	(0.6641)	(0.5133)	(0.0831)	(0.0504)	(0.3621)	(0.1917)	(0.1535)	(0.1737)
Sucumbios	*Mean*	0.1509	2.8130	9.5205	2.3235	1.5635	-2.1914	4.5114	4.8515
	(SD)	(0.4735)	(0.8351)	(0.2879)	(0.0624)	(0.3240)	(0.5529)	(0.1760)	(0.2384)
Tungurahua	*Mean*	0.0719	3.0271	7.9806	5.0484	3.3975	-0.9581	5.3585	7.0333
	(SD)	(0.1770)	(0.2243)	(0.0734)	(0.0336)	(0.1899)	(0.2239)	(0.2055)	(0.2585)
Zamora Chinchipe	*Mean*	0.1887	1.0419	7.4902	2.2187	1.0729	-2.2455	4.3161	4.4346
	(SD)	(0.4933)	(0.6425)	(0.0703)	(0.0563)	(0.2489)	(0.3422)	(0.1436)	(0.0555)
Ecuador	***Mean***	***0.0765***	***2.3592***	***8.0917***	***3.6981***	***2.4488***	***-1.7408***	***4.8924***	***6.0540***
	(SD)	***(0.3711)***	***(0.8863)***	***(0.6891)***	***(1.3224)***	***(1.0130)***	***(0.6666)***	***(0.4508)***	***(1.2808)***

Table 3.3

Correlation coefficients

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1.	$\Delta ln(i_{jt})$	1												
2.	$ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$	0.2442	1											
3.	$ln(y_{jt-1})$	-0.0909	0.6199	1										
4.	$ln\left(\frac{N_{jt-1}}{S_j}\right)$	0.0963	0.2975	-0.3437	1									
5.	$ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)$	-0.0251	0.4808	0.0106	0.7874	1								
6.	$ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)$	-0.0847	0.1886	-0.1193	0.6265	0.6988	1							
7.	$ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)$	-0.1055	0.2438	0.0364	0.5708	0.6221	0.3266	1						
8.	$ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)$	0.0452	0.3269	-0.1792	0.8331	0.7817	0.6079	0.4157	1					
9.	PS_{jt}	-0.1585	-0.0761	-0.1852	0.4914	0.4062	0.3553	0.5126	0.3744	1				
10.	D_{jt}^{P}	0.0327	0.1397	-0.1959	0.5031	0.4589	0.4578	0.2446	0.4251	0.2984	1			
11.	MV_{jt}	0.1972	0.2519	-0.0747	0.3767	0.3471	0.1687	0.321	0.2578	0.3017	0.4654	1		
12.	MS_{jt}	0.0744	0.2031	-0.1193	0.4095	0.3554	0.1632	0.4363	0.2200	0.3984	0.4040	0.8316	1	
13.	D_{jt}^{M}	0.2166	0.2186	0.0793	0.1258	0.1279	0.0063	0.2040	0.0282	0.1693	0.2107	0.8226	0.6443	1

Table 3.4.

Panel Data Regression of equation (13) with fixed effects

	Coefficients	**OLS SE**	**Robust SE**
Constant	8.3820	8.2679	7.9144
Equity-efficiency trade-off			
$Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$	0.6484	0.0818***	0.0759***
$Ln(y_{jt-1})$	-1.0214	0.2286***	0.2532***
Special public capital needs			
$Ln\left(\frac{N_{jt-1}}{S_j}\right)$	-1.3347	1.9213	1.8070
$Ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)$	-0.0393	0.0800	0.0794
$Ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)$	-0.1653	0.1532	0.0794**
$Ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)$	0.4489	0.3258	0.2547*
$Ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)$	-0.1080	0.1289	0.1158
Political factors			
PS_{jt}	0.4939	0.2448**	0.2361**
D_{jt}^{P}	-0.0836	0.1053	0.0787
MV_{jt}	0.4300	0.6550	0.6406
MS_{jt}	-0.2853	0.2262	0.1914
D_{jt}^{M}	-0.0268	0.1364	0.1591
Time dummies			
τ_{2010}	-0.0073	0.0966	0.1018
τ_{2011}	0.0555	0.1061	0.0964
τ_{2012}	0.3132	0.1607*	0.1323**
τ_{2013}	0.3092	0.2020	0.1594*
τ_{2014}	0.1665	0.2435	0.1900
τ_{2015}	-0.1287	0.2854	0.2293
R^2	0.6030		
H^{FR}	44.9300 (0.0000)		
H^{E}	-12.0400 (NA)		
DM	0.2550 (0.6146)		
Sargan test	0.0090 (0.9262)		

***, **, * Significant at the 1%, 5% and 10% levels; respectively.

Table 3.5.

Panel Data Regression of equation (13) with fixed effects. Variables measured per active population

	Coefficients	**OLS SE**	**Robust SE**
Constant	3.0956	3.1028	3.1728
Equity-efficiency trade-off			
$Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$	0.6250	0.0825***	0.0916***
$Ln(y_{jt-1})$	-0.9565	0.2254***	0.2469***
Special public capital needs			
$Ln\left(\frac{N_{jt-1}}{S_j}\right)$	0.1732	0.4104	0.3914
$Ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)$	-0.0425	0.0728	0.0721
$Ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)$	-0.1794	0.1395	0.0888*
$Ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)$	0.6555	0.3287**	0.2382**
$Ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)$	-0.0192	0.1354	0.1142
Political factors			
PS_{jt}	0.5226	0.2448**	0.2235**
D_{jt}^{P}	-0.0763	0.1046	0.0744
MV_{jt}	0.4149	0.6435	0.6330
MS_{jt}	-0.3878	0.2225	0.1959*
D_{jt}^{M}	-0.0041	0.1365	0.1507
Time dummies			
τ_{2010}	0.0201	0.0903	0.1096
τ_{2011}	0.0946	0.1066	0.1042
τ_{2012}	0.2350	0.1398*	0.1283*
τ_{2013}	0.1500	0.1612	0.1378
τ_{2014}	-0.0662	0.1931	0.1728
τ_{2015}	-0.4481	0.2246	0.1951
R^2	0.6201		
H^{FR}	51.6600 (0.0000)		
H^{E}	7.7100 (0.8073)		
DM	0.8201 (0.3673)		
Sargan test	0.0370 (0.8476)		

***, **, * Significant at the 1%, 5% and 10% levels; respectively.

Table 3.6.

Panel data regression of equation (13) with fixed effects including investment by provincial governments

	Per capita		Per active population	
	Coefficients	**Robust SE**	**Coefficients**	**Robust SE**
Constant	8.7446	8.1532	2.7588	3.2845
$Ln(i_{it}^{p})$	-0.0258	0.1044	0.0900	0.1239
Equity-efficiency trade-off				
$Ln\left(\frac{y_{jt-1}}{i_{jt-1}}\right)$	0.6496	0.0779***	0.6233	0.0887***
$Ln(y_{jt-1})$	-1.0219	0.2533***	-0.9639	0.2474***
Special public capital needs				
$Ln\left(\frac{N_{jt-1}}{S_j}\right)$	-1.3924	1.8542	0.1346	0.4085
$Ln\left(\frac{V_{jt-1}}{Km_{jt-1}}\right)$	-0.0372	0.0808	-0.0513	0.0748
$Ln\left(\frac{SE_{jt-1}}{N_{jt-1}}\right)$	-0.1679	0.0781**	-0.1671	0.0870*
$Ln\left(\frac{ES_{jt-1}}{EI_{jt-1}}\right)$	0.4550	0.2533*	0.6177	0.2362**
$Ln\left(\frac{HB_{jt-1}}{N_{jt-1}}\right)$	-0.0995	0.1160	-0.0532	0.1239
Political factors				
PS_{jt}	0.4959	0.2369**	0.5125	0.2215**
D_{jt}^{P}	-0.0868	0.0865	-0.0649	0.0822
MV_{jt}	0.4102	0.5970	0.4763	0.5862
MS_{jt}	-0.2780	0.1871	-0.4024	0.1933**
D_{jt}^{M}	-0.0227	0.1512	-0.0193	0.1414
Time dummies				
τ_{2010}	-0.0099	0.1029	0.0279	0.1089
τ_{2011}	0.0558	0.0967	0.0903	0.1039
τ_{2012}	0.3165	0.1308**	0.2356	0.1275*
τ_{2013}	0.3141	0.1604*	0.1544	0.1379
τ_{2014}	0.1708	0.1923	-0.0522	0.1713
τ_{2015}	-0.1191	0.2367	-0.4441	0.1938**
R^2	0.6031		0.6223	
H^E	3.3000 (0.9966)		16.2000 (0.2386)	
DM	0.4389 (0.5092)		0.1710 (0.6801)	
Sargan test	0.2190 (0.6400)		0.3900 (0.5320)	

***, **, * Significant at the 1%, 5% and 10% levels; respectively.

Chapter 4

Fiscal Decentralization and the Allocation of Public Spending of Subnational Governments: The case of Ecuador

Abstract

This article analyzes the public spending allocation criteria followed by the Ecuadorian subnational governments during the period 2001–2015. It is especially focused on testing the relationship between fiscal decentralization and the growth rate of the public spending per capita at provincial level. A theoretical model is proposed to support the empirical strategy. Two variables to capture fiscal decentralization are proposed: financial autonomy and tax autonomy. The estimation results show that *i)* financial autonomy is positively related to the growth rate of regional public. *ii)* The growth rate of public current spending per capita is correlated positively with financial autonomy and correlated negatively with the tax autonomy. Hypothesis testing shows that "such opposite effects" cancel out.

Keywords: Ecuadorian subnational governments, decentralization, public spending.

JEL classification: H53; H77; C23

4. *Fiscal decentralization and the allocation of public spending of subnational governments: The case of Ecuador*

4.1. Introduction

In the last three decades Ecuador, as many other countries around the world, has been involved into a decentralization process by which the central government has been granting subnational governments administrative and fiscal responsibilities[48] along with financial resources to become more efficient in the provision of public goods and services and with the aim of boosting economic growth and reducing the inequality gap between municipalities and provinces (Senplades, 2012).

Historically, the allocation of public resources has been concentrated in a few Ecuadorian jurisdictions[49], increasing the regional gap in terms of income, productivity, infrastructure and poverty and, as many historians and politicians have stated, this concentration of wealth, in addition to the slow response of the central and subnational governments in the provision of public goods and services, among other factors, has caused Ecuador to have an unstable economic growth and development (Segovia, 1998; Arroba, 2007; Acosta, 2012).

This article analyzes the allocation of public spending made by the Ecuadorian subnational governments during the period 2001-2015. We follow the methodology by Aray and Pacheco-Delgado (2020) who tested the allocation of public investment of the Ecuador's central government. However, this article differs largely from Aray and Pacheco-Delgado (2020) in: first; we focus on subnational governments, both, provincial and municipal governments. Second, we are interested, not only in the allocation of public investment, but also in the allocation of public current spending. Public investment is aimed at increasing the public capital and current spending is aimed at increasing the human capital (Diamond, 1990; Baldacci, Clements, Gupta & Cui; 2008, among others.). And third, and more importantly, we especially focus on the relationship between fiscal decentralization and the growth rate of the public spending per capital of the subnational governments. In order to do that, two variables that

[48] See Faust and Harbers (2011).

[49]According to the Central Bank of Ecuador, by 2015, at least the 70% of the economic activities were concentrated in four provinces: Guayas, Pichincha, Azuay and Manabí.

capture fiscal decentralization are proposed: the financial autonomy and the tax autonomy. The former measures the ratio of the own revenues of the subnational governments to the transfers from the general state budget. The latter is measured as the share of the tax collected by the subnational governments on the total taxes collected in the provinces regardless the collector.

A very important strand of the literature analyzes the relationship between decentralization and economic performance. The most studied nexus has been the relationship between fiscal decentralization and economic growth (Martínez-Vázquez and McNab, 2003; Baskaran, Feld and Schnellenbach (2016) and Martínez-Vázquez, Lago-Peñas and Sacchi, 2017). The relationships of fiscal decentralization with the composition and the efficiency of public expenditures have also been largely studied. Regarding the composition of the public expenditures, relevant references are Kappeler and Välilä (2008), Jia, Guo and Zhang (2014), Grisorio and Prota (2015a, 2015b)), González-Alegre (2010) and Arze del Granado, Martinez-Vazquez and McNab (2018). Regarding efficiency, we find the works by Balaguer-Coll, Prior and Tortosa-Ausina (2010), Boetti, Piacenza and Turati (2012) and Brehm (2013) and Adam, Delis and Kammas (2014).

The relationship between fiscal decentralization and public spending allocation has been much less studied as can be checked in the survey of the literature by Martínez-Vázquez *et al*. (2017). Interesting references are Kappeler, Solé-Ollé and Välilä (2013) who found a positive relationship between revenue decentralization and the provision of public infrastructure at the sub-national level in 20 European countries. Similar results were found by González-Alegre (2015) and Aray (2019) for the case of Spain.

For the case of Latin American countries, hardly evidence can be found on the relationship between fiscal decentralization and public spending. De Mello (2010) cast evidence for a panel of Latin American countries and suggested that fiscal decentralization is negatively correlated with the investment-to-GDP ratio of subnational governments. Regarding single country studies, Faguet (2004) found that fiscal decentralization is positively correlated with the provision of public investment of subnational governments and concluded that decentralization significantly changed public investment patterns in Bolivia, especially in the poorest regions which has been beneficial for the development of smaller and lagging municipalities.

Therefore, this article provides evidence on this topic studied scarcely in Latin America. Precisely, the Interamerican Development Bank (IDB), in a series of articles

collected by Fretes and Ter-Minassian (2015) suggested that more local autonomy to generate and manage tax revenue could promote greater local development and efficiency. This is especially interesting because Latin American sub-national governments rely heavily on transfers to finance their spending.

The case of Ecuador is interesting because, since the returning to the democracy in 1979, the country has undergone a high political instability and fragmentation, which has made difficult the governability and the achievement of stable political agreements, such as the administrative and fiscal decentralization. The political fragmentation has also prevented that the same political party from getting the Presidency of the Republic on more than one occasion, not to mention that the party of the president-elect had achieved a majority in the national parliament only two times until 2009 when the acting president was re-elected for a second term and his political organization won the majority in the parliament with 43% of the seats, while the second majority obtained only 15% of the seats. It is worth mentioning that, in a span of ten years (1998 and 2008), Ecuador has reformed its constitution twice. The Constitution of 2008 is the country's twentieth Magna Carta since Ecuador became an independent nation in 1830. This could be seen as a symptom of political instability (Negretto, 2009, 2015).

Although, the beginning of the decentralization process can be found in the 70's with the administrative decentralization, it was not until the late 90's that this process started emerging. Constitution of 1998 made progress in the administrative decentralization (Tello-Toral and Lucio-Vásquez, 2019). However, it did not advance in the fiscal decentralization.

The Constitution of 2008 gave a great boost to the decentralization process. The new Constitution provides a model of territorial and administrative division for a more accountability in the allocation of public resources. Thus, the Decentralized Autonomous Governments (GAD) were created, which are public institutions that shape the administrative organization of the country's territory. They have to consider the criteria of efficiency, equity and redistribution when allocating the resources generated by themselves, as well as, those transferred from the general state budget through the General State budget. In doing so, central and subnational governments must fulfill one of the main objectives of the National Plan of Good Living (Plan Nacional del Buen Vivir), that is, to reduce poverty and inequality across Ecuadorian provinces (Senplades, 2009).

In addition, the new model of decentralization, framed in the Constitution of 2008, promotes the fiscal decentralization and establishes tax responsibilities by layers of government. Therefore, the main taxes, fees and special contributions assigned to the GAD are clearly defined.

Strikingly, Ecuador has had political decentralization because provincial prefects and municipal mayors have been elected through direct popular vote since 1945. With the development of the administrative and fiscal decentralization, subnational authorities have gained financial and administrative autonomy, which has allowed them to make decisions on public spending in their jurisdictions. This is very important, because subnational governors can be motivated by factors different to those of the central governor.

In order to provide empirical evidence on the relation between fiscal decentralization and public spending in Ecuador, a theoretical model is proposed in which the regional/local planners choose the level of the public spending that maximize the regional collective welfare subject to the several constraints. The model allows to get equations for the growth rates of the investment per capita and the current public expenditures per capita. The equations capture the traditional criteria for public spending allocation: equity-efficiency trade off, special needs and political factors. Moreover, by introducing fiscal variables, we are able to test the relationship between the growth rate of public spending per capita and fiscal decentralization.

In the empirical implementation, a panel data of twenty-two provinces[50] for the period 2001-2015 will be used for the analysis. All information has been provided by the Central Bank of Ecuador, the Ministry of Economy and Finance, the National Institute of Statistics, the Internal Revenue Service, the National Secretary of Planning and Development, the Autonomous Decentralized Governments, among other official information sources. Estimation results show that financial autonomy is correlated positively with the growth rate of public spending per capita. However, opposite signs of the correlation coefficients of financial autonomy and tax autonomy with the growth rate of public current spending suggests that such relationships cancel out.

The organization of this paper is as follows: Section 2 provides an overview of the Ecuadorian administrative system and the financing of subnational governments.

[50]Although Ecuador is divided into twenty-four provinces since 2008, to take advantage of the information available since 2001, we will be using the previous administrative division, that is, 22 provinces.

Section 3 shows the theoretical model. The empirical strategy is explained in section 4. Estimation results are discussed in Section 5, while main conclusions are presented in section 6.

4.2. The Ecuadorian administrative system and financing of sectional governments

4.2.1. The administrative system

4.2.1.1. The central government

The President is the highest authority and is responsible for the control and administration of the central government and national public companies. He or she is elected by popular vote and holds office during the term of four years. As the person in charge of the Executive branch, the President is also responsible of appointing the Secretaries of State, Regional Governors and other servants of the public administration. The President has exclusive competencies over national security, national planning, and the preparation and administration of the general state budget, as well as the economic, fiscal and social policies, among other competences that cannot be transferred to subnational governments.

4.2.1.2. The decentralized autonomous governments

According to the 2008 Constitution, these public institutions enjoy political, administrative and financial autonomy and assume specific competencies such as the planning and managing of their territory as well as to ensure the proper functioning of public services and physical infrastructure. There are four levels of decentralized autonomous governments: regional, provincial, cantonal and rural parishes. As the figure of regional governments has not yet been fully implemented, they do not have a budget or established authority.

4.2.1.2.1. Provincial governments

The provincial governments are the intermediate level of territorial and administrative organization. Their competences are those that cannot be placed at the local and at the national level. Such competences are the planning, construction and maintenance of the provincial road systems excluding urban areas, irrigation system and other public services and infrastructure to secure productive development of the

province. In addition, provincial governments are in charge of the provincial environmental management and must promote provincial productive activities, especially, the agricultural sector. The Provincial Councils were established by the 1928 Constituent Assembly. The Provincial Prefect is the highest authority and is elected by popular vote. Currently, there are 24 provinces in Ecuador.[51]

4.2.1.2.2. Municipal and metropolitan district governments

The municipalities or cantons are the second level of administrative division and the local level of territorial organization; therefore, the municipal governments have a greater proximity to the citizens. Their main competences are the control over the use and occupation of the land, the planning, construction, provision and maintenance of urban roads, drinking water, sanitary sewer and physical infrastructure of health and education, as well as the solid waste management, environmental sanitation activities, the regulation and control of transit and public transport and the preservation and dissemination of the architectural, cultural and natural heritage of the canton. The Mayor is the highest authority and is elected by popular vote. Nowadays, there are 221 cantons in Ecuador. [52]

4.2.1.2.3. Rural parish governments

The rural parishes are part of a canton's territory; however, they are decentralized governments with exclusive competences and budgetary management because of geographical conditions. In most cases, rural parishes are so far from the urban centers where the cantonal authorities are located. The rural parish is governed by a Parish Committee composed of members elected by popular vote. Currently, there are 790 rural parishes.

4.2.2. Financing of subnational governments

The Ecuadorian subnational governments finance their current and capital expenditures in three ways: i) by collecting their own taxes and fees, ii) through central government financial transfers, and iii) loans and donations. Like in most of Latin American countries, transfers from the general state budget are the most prominent source of income for subnational governments. A study carried out by Gómez-Sabaini and Jiménez (2011) on the financing of subnational governments in nine Latin

[51] See COOTAD (2010).
[52] See COOTAD (2010).

American countries, shows that own resources generated by Ecuadorian subnational governments represented at least 1.2% of GDP in 2008, only above of Costa Rica (0.9%) and Peru (0.8). This low revenue collection is due to the weakness in the structure of subnational taxation derived from the limited tax bases available from these levels of government. Figure 4.1 shows the own revenues generated by the subnational governments as a percentage of national GDP during the period 2000-2015.

In Ecuador, like many other unitary states, efforts to decentralize central government functions have caused major fiscal imbalances in subnational governments, especially in intermediate level governments such as prefectures (Fretes and Ter-Minassian, 2015). This is even more accentuated in oil dependent countries (Cueva and Ortiz, 2013). Although oil revenues have been losing weight in the share of total revenues for central government in recent years, this is not the case for subnational governments. In fact, transfers to subnational government depend largely on oil revenues. Therefore, transfers are still an important source for financing subnational governments. Figure 4.2 shows the evolution of oil revenues and transfers to subnational government during the period 2000-2015.

According to Arroba (2007) and Senplades (2012), the dependency on oil revenues shows the lack of effort of subnational governments to procure their own resources and, thus, making evident their lack of commitment. In addition, there are autonomous governments that do not have the capacity and size to generate their own resources and to manage their competencies and they are not able to take advantage of economies of scale in tax collection (Fretes and Ter-Minassian, 2015). In order to change this situation, Ecuador had to reform its fiscal legislation. Before 2008, the country had at least 18 special laws to ensure the transfer of financial resources to subnational governments, such as the "1997 Law of Special Distribution of 15% of the General Budget". Such amount of laws made difficult the allocation and management of public resources. Moreover, as claimed by Arias *et al*. (2008), Ecuador's tax system was ineffective, partly, due to economic group pressures and political weakness. The Constitution of 2008 eliminated some of those laws and reformed some others. The main difference between this constitution and the previous ones is that the allocation of financial resources to subnational governments are accompanied by the mandatory transfer of responsibilities they must assume according to the law (Senplades, 2012; COOTAD, 2010).

Regarding the participation of subnational governments in the general state budget, the Constitution (Article 271) established that they will participate of at least 15% of the permanent revenues[53] and no less than 5% of the non-permanent revenues[54] of the general budget of the State. However, in 2010 these percentages were modified by the Organic Code for Territorial Organization, Autonomy and Decentralization (COOTAD)[55], establishing that sectional governments will receive at least 21% of the permanent revenues and 10% of the non-permanent revenues of the general state budget. These percentages will be distributed among the subnational governments as follows: 27% for the provincial councils, 67% for municipalities and metropolitan districts, and 6% for rural parish boards. The COOTAD also establishes that current expenses shall be financed by permanent revenues to avoid liquidity problems due to fall in the prices of oil and other raw materials or any other external shock. This is seen by the central government as a measure to reduce the procyclicality of the Ecuadorian economy.[56]

The COOTAD also grants greater power to provincial and municipal governments to generate and manage own resources.[57] Nevertheless, as mentioned above, these revenues are not enough to cover their basic expenses hence their strong dependence on state resources.

As a result of changes in the tax system, fiscal pressure has been a key issue for the country's finance in this decade, going from 9.2% in the share of GDP in the year 2000 to 21.7% in 2015 allowing Ecuador to become one of the countries with the greatest fiscal pressure in Latin America (Ocampo, 2017).[58] Article 300 of the Constitution of 2008 states that tax collection must be progressive and efficient to achieve the objectives of redistribution and social justice.

[53]Permanent revenues includes: taxes; fees and contributions; sale of goods and services; investment returns and fines; current transferences and donations, others.
[54]Non-permanent revenues includes: sale of non-financial assets; transfers and donations of capital and investment.
[55]The COOTAD is the legal framework for the territorial organization and operation of the GAD. It is in force since October 2010.
[56] Snudden (2016) found that countercyclical fiscal and monetary policies can reduce output variability, inflation in oil-exporting countries.
[57] However, parish councils are not authorized to generate own resources.
[58] However, this is due to the central government.

4.3. Theoretical model

The collective welfare of the province j is expressed by the subnational (provincial and local) planner as follows

$$W_{jt} = N_{jt} y_{jt}^{\rho} \Psi_{jt}^{1-\rho} \qquad (1)$$

Where y_{jt} is the per capita income in the province j, Ψ_{jt} collects province's economic, social and demographic variables and any other relevant characteristics, other than political factors, that are assumed to affect the utility of the individuals. N_{jt} is the population. If $\rho = 1$, the regional planner only cares about the total income/output of the province.

The provincial economy j produces an output, Y_{jt} in each period t according to a Cobb-Douglas production function as follows:

$$Y_{jt} = A_{jt} K_{jt}^{\mu_j} H_{jt}^{\phi_j} G_{jt}^{\theta_j} \qquad 0 < \mu_j, \phi_j, \theta_j < 1 \qquad (2)$$

Where K_{jt} is the non-residential private capital stock, H_{jt} is the human capital input, G_{jt} is the public capital stock and A_{jt} is the total factor productivity. μ_j, ϕ_j, θ_j are the elasticities of the output with respect to the inputs.

Following Hercowitz and Sampson (1991), Kocherlakota and Yi (1997) and Cassou and Lansing (1998), let G_{jt} and H_{jt} accumulate according to the following laws:[59]

$$G_{jt} = G_{jt-1}^{1-\left(\sigma_j^G + \vartheta_j^G\right)} CI_{jt}^{\sigma_j^G} RI_{jt}^{\vartheta_j^G} \qquad (3)$$

$$0 < \sigma_j^G, \vartheta_j^G \leq 1\,; \quad 0 < \sigma_j^G + \vartheta_j^G \leq 1$$

$$H_{jt} = H_{jt-1}^{1-\left(\sigma_j^H + \vartheta_j^H\right)} CC_{jt}^{\sigma_j^H} RC_{jt}^{\vartheta_j^H} \qquad (4)$$

$$0 < \sigma_j^H, \vartheta_j^H \leq 1\,; \quad 0 < \sigma_j^H + \vartheta_j^H \leq 1$$

Where CI_{jt} (CC_{jt}) and RI_{jt} (RC_{jt}) are the public capital investments (current expenditures) in province j in period t made by the central and subnational governments, respectively. Following Diamond (1990) and Baldacci *et al*. (2008), we assume that current expenses become an input for human capital accumulation since they include salary in education and health public sectors.

[59] These authors used similar expressions to model the evolution of private capital stock.

The advantages of specifications as the type of equation (3) and (4) with respect to the standard linear form is that the former exhibits decreasing returns has been highlighted by Cassou and Lansing (1998) who pointed out that such specifications reflect adjustment costs in increasing the volume of capital stock or diminishing returns of the investment and capture the behavior of an aggregate stock that is measured by adding up different types of capital which individually display different depreciation characteristics.

The objective of the regional planner is to choose the levels of RI_{jt} and RC_{jt} that maximize equation (1) subject to equations (2), (3), (4) and the budget constraint

$$RI_{jt} + RC_{jt} \leq \mathrm{RR}_t \qquad (5)$$

Being RR_t the resource constraint of the regional planner.

The first order conditions of the maximization problem are

$$\frac{\partial W_t}{\partial y_{jt}} \cdot \frac{\partial y_{jt}}{\partial G_{jt}} \cdot \frac{\partial G_{jt}}{\partial RI_{jt}} - \lambda_t = 0 \qquad (6)$$

$$\frac{\partial W_t}{\partial y_{jt}} \cdot \frac{\partial y_{jt}}{\partial H_{jt}} \cdot \frac{\partial H_{jt}}{\partial RC_{jt}} - \lambda_t = 0 \qquad (7)$$

Where λ_t is the Lagrange multiplier, which can be interpreted as the marginal cost of public revenues.

Substituting partial derivatives in (6) and (7), the following equations are obtained

$$\rho\theta_j\vartheta_j^G N_{jt}\Psi_{jt}^{1-\rho} y_{jt}^{\rho-1}\frac{y_{jt}}{RI_{jt}} - \lambda_t = 0 \qquad (8)$$

$$\rho\phi_j\vartheta_j^H N_{jt}\Psi_{jt}^{1-\rho} y_{jt}^{\rho-1}\frac{y_{jt}}{RC_{jt}} - \lambda_t = 0 \qquad (9)$$

The solution of this maximization problem provides the optimal levels of public investment and current expenditure per capita made by the subnational government of the province *j* in year *t*

$$\widehat{ri}_{jt} = \frac{\rho\theta_j\vartheta_j^G}{\lambda_t}\Psi_{jt}^{1-\rho} y_{jt}^{\rho-1} y_{jt} \qquad (10)$$

$$\widehat{rc}_{jt} = \frac{\rho\phi_j\vartheta_j^H}{\lambda_t}\Psi_{jt}^{1-\rho} y_{jt}^{\rho-1} y_{jt} \qquad (11)$$

Where $\widehat{ri}_{jt} = \widehat{RI}_{jt}/N_{jt}$ and $\widehat{rc}_{jt} = \widehat{RC}_{jt}/N_{jt}$.

Following the literature, we also consider that there exist political factors that could deviate the allocation of public spending from the optimal rules. Therefore, consider that the per capita public investment and per capita current expenditures made by the subnational governments in province *j* in year *t*, ri_{jt} and rs_{jt}, adjust toward the optimal level according to the following equations:

$$\frac{ri_{jt}}{ri_{jt-1}} = e^{\left(z_{jt}^{i}+\varepsilon_{jt}^{i}\right)}\left(\frac{\widehat{ri}_{jt}}{ri_{jt-1}}\right)^{\gamma^{i}}, \quad 0 \leq \gamma^{i} \leq 1 \qquad (12)$$

$$\frac{rc_{jt}}{rc_{jt-1}} = e^{\left(z_{jt}^{c}+\varepsilon_{jt}^{c}\right)}\left(\frac{\widehat{rc}_{jt}}{rc_{jt-1}}\right)^{\gamma^{c}}, \quad 0 \leq \gamma^{c} \leq 1 \qquad (13)$$

Where parameters γ^{i} and γ^{c} are the adjustment coefficients toward the optimal level of per capita public investment; z_{jt}^{i} and z_{jt}^{c} are exogenous deterministic shocks caused by political factors; ε_{jt}^{i} and ε_{jt}^{c} are random disturbance with expected values equal to zero and *e* is the exponential operator.

By substituting equation (10) in (12) and equation (11) in (13) and taking natural logarithm, we obtain:

$$\Delta Ln\left(ri_{jt}\right) = z_{jt}^{i} + \gamma^{i} Ln\left(\frac{\rho\theta_{j}\vartheta_{j}^{G}}{\lambda_{t}}\Psi_{jt}^{1-\rho}y_{jt}^{\rho-1}\frac{y_{jt}}{ri_{jt-1}}\right) + \varepsilon_{jt}^{i} \qquad (14)$$

$$\Delta Ln\left(rc_{jt}\right) = z_{jt}^{c} + \gamma^{c} Ln\left(\frac{\rho\phi_{j}\vartheta_{j}^{H}}{\lambda_{t}}\Psi_{jt}^{1-\rho}y_{jt}^{\rho-1}\frac{y_{jt}}{rs_{jt-1}}\right) + \varepsilon_{jt}^{c} \qquad (15)$$

As can be noticed equations (14) and (15) captures the development indicator (y_{jt}), and indicators for the productivity of the public spending ($\frac{y_{jt}}{ri_{jt-1}}$ and $\frac{y_{jt}}{rs_{jt-1}}$)

4.4. Empirical strategy

When the local governments plan the public spending relies on the available information. Therefore, let us rewrite equations (14) and (15) considering the lag in the output per capita,

$$\Delta Ln\left(ri_{jt}\right) = z_{jt}^{i} + \gamma^{i} Ln\left(\frac{\rho\theta_{j}\vartheta_{j}^{G}}{\lambda_{t}}\Psi_{jt}^{1-\rho}y_{jt-1}^{\rho-1}\frac{y_{jt-1}}{ri_{jt-1}}\right) + \varepsilon_{jt}^{i} \qquad (16)$$

$$\Delta Ln(rc_{jt}) = z_{jt}^{c} + \gamma^{c} Ln\left(\frac{\rho\phi_j\vartheta_j^H}{\lambda_t}\Psi_{jt}^{1-\rho}y_{jt-1}^{\rho-1}\frac{y_{jt-1}}{rs_{jt-1}}\right) + \varepsilon_{jt}^{c} \quad (17)$$

In addition, for the empirical implementation we need to specific forms for Ψ_{jt}, z_{jt}^{i} and z_{jt}^{c}. Thus, Ψ_{jt} is specified similar to Aray and Pacheco-Delgado (2020). However, it is extended to capture, not only special needs as Aray and Pacheco-Delgado (2020), but also, fiscal variables. Again, when the local governments plan the expenditures related to special needs of the year *t* has available information for the *t-1* year. Therefore, variables related to special needs are included with one lag. However, fiscal variables are considered in their current values since that local government funds their expenditures in year *t* with transfers from the central government and their own income in year *t*. Thus, Ψ_{jt} is specified as follows:

$$\Psi_{jt} = D_{jt-1}^{\varphi_1}V_{jt-1}^{\varphi_2}TC_{jt-1}^{\varphi_3}EI_{jt-1}^{\varphi_4}HI_{jt-1}^{\varphi_5}SA_{jt-1}^{\varphi_6}ST_{j-1}^{\varphi_7}tr_{jt}^{\varphi_8}FA_{jt}^{\varphi_9}TA_{jt}^{\varphi_{10}} \quad (18)$$

Where φ_m, for $m = 1, 2, ..10$, are parameters.

The variables that control for special needs are, typically, intended to capture the so-called agglomeration and congestion effects. Thus, D_{jt}, is the population density that captures agglomeration, which often comes along with congestion, in both, hard and soft infrastructure. Therefore, V_{jt}, the ratio between the number of registered vehicles and the kilometers of roads built and TC_{jt}, the number of seats available for passenger in public transport (buses) per capita, are the variables that capture the congestion in hard infrastructure. In order to capture congestion in soft infrastructure, we include indicators for education and health. Thus, EI_{jt} is the ratio of students enrolled in primary and secondary schools per school and HI_{jt} is the number of beds in hospitals per capita.

We also consider special needs related to the sectors in which subnational governments have more competencies, say, agriculture and tourism. Thus, the shares of gross value added (GVA) of agriculture, SA_{jt}, and restaurants and hotels, ST_{jt},[60] on the total provincial GVA, are included.

Regarding fiscal variables, we have to control for the transfers from the central government to subnational governments, which become most of the resources of the subnational governments and, therefore, are expected to affect the welfare of the individuals. Hence, tr_{jt} is the per capita transfer from the central government to

[60] We have to rely on a proxy for the GVA of the tourism sector because unavailable data.

subnational governments. In order to capture fiscal decentralization, which is the main objective in this study, two variables are included. FA_{jt}, is the share of own revenues (tax, fees and other special contributions) of the subnational government on the transfers from the general state budget and it is intended to capture the financial autonomy. TA_{jt} is the share of tax revenues collected by subnational governments on the total taxes collected by the layers of governments (central, provincial and municipal taxes) in the province, and it is intended to capture the tax autonomy.

Regarding political variables, z_{jt}^{i} and z_{jt}^{s} are specified as follows:

$$z_{jt}^{i} = \alpha_1^i SR_{jt} + \alpha_2^i D_{jt}^{PR} + \alpha_3^i D_{jt}^{MR} \quad (19)$$

$$z_{jt}^{c} = \alpha_1^c SR_{j} + \alpha_2^c D_{jt}^{PR} + \alpha_3^c D_{jt}^{MR} \quad (20)$$

Where SR_{jt} is the share of right-wing parliaments in province *j* in year *t*, D_{jt}^{PR} is a dummy variable that takes on the value 1 if the prefect of the province *j* in year *t* belongs to a right party, and zero, otherwise, and D_{jt}^{MR} is a dummy variable that takes on the value 1 if the majors of the province *j* in year *t* are mostly right-winged, and zero, otherwise.

Substituting equation (18) and (19) in equation (16) and equations (18) and (20) in equation (17), we obtain

$$\Delta Ln(ri_{jt}) = \delta^i + \delta_j^i + \tau_t^i + \gamma^i Ln\left(\frac{y_{jt-1}}{ri_{jt-1}}\right) + \beta_1^i Ln\left(y_{jt-1}\right) + \beta_2^i Ln\left(D_{jt-1}\right) + \beta_3^i Ln\left(V_{jt-1}\right) + \beta_4^i Ln\left(TC_{jt-1}\right) + \beta_5^i Ln\left(EI_{jt-1}\right) + \beta_6^i Ln\left(HI_{jt-1}\right) + \beta_7^i Ln\left(SA_{jt-1}\right) + \beta_8^i Ln\left(ST_{jt-1}\right) + \beta_9^i Ln\left(tr_{jt}\right) + \beta_{10}^i Ln\left(FA_{jt}\right) + \beta_{11}^i Ln\left(TA_{jt}\right) + \alpha_1^i SR_{jt} + \alpha_2^i D_{jt}^{PR} + \alpha_3^i D_{jt}^{MR} + \varepsilon_{jt}^i \quad (21)$$

$$\Delta Ln(rc_{jt}) = \delta^c + \delta_j^c + \tau_t^c + \gamma^c Ln\left(\frac{y_{jt-1}}{rc_{jt-1}}\right) + \beta_1^c Ln\left(y_{jt-1}\right) + \beta_2^c Ln\left(D_{jt-1}\right) + \beta_3^c Ln\left(V_{jt-1}\right) + \beta_4^c Ln\left(TC_{jt-1}\right) + \beta_5^c Ln\left(EI_{jt-1}\right) + \beta_6^c Ln\left(HI_{jt-1}\right) + \beta_7^c Ln\left(SA_{jt-1}\right) + \beta_8^c Ln\left(ST_{jt-1}\right) + \beta_9^c Ln\left(tr_{jt}\right) + \beta_{10}^c Ln\left(FA_{jt}\right) + \beta_{11}^c Ln\left(TA_{jt}\right) + \alpha_1^c SR_{jt} + \alpha_2^c D_{jt}^{PR} + \alpha_3^c D_{jt}^{MR} + \varepsilon_{jt}^c \quad (22)$$

Where $\beta_1^l = \gamma^l(\rho - 1)$, $\beta_h^l = \gamma^l(1-\rho)\varphi_h$ and $\delta^l + \delta_j^l + \tau_t^l = \gamma Ln\left(\frac{\rho\theta_j\vartheta_j^G}{\lambda_t}\right)$ for $l = i, c,$ and $h = 2,3,4,\ldots,11$. δ^l, δ_j^l, and τ_t^l are the constant term, the individual effect and the time effect, respectively.

According to the theoretical model, it is expected that $0 \leq \gamma^l \leq 1$ and $\beta_1^l = \gamma^l(\rho - 1) < 0$. Subnational governments face a dilemma when allocating public resources, since they must invest in the most productive projects but also invest in alternative projects to compensate income decrease and poverty in order to improve social welfare.

Regarding fiscal decentralization variables, the seminal works of Tiebout (1961) Musgrave (1969) and Oates (1972) suggested that decentralization brings efficiency in the allocation of resources since regional and local governments know better the needs and preferences of their citizens, which should have a positive effect over the provision of public good and services. Therefore, it is expected that β_{10}^l and $\beta_{11}^l \geq 0$.

4.5. Estimation results

Tables 4.1 and 4.2 shows estimation results of equations (21) and (22). Let us start with the results for the growth rate of public investment per capita in Table 4.1. Hausman test shows evidence in favor of fixed effects. In addition, In addition, Green test rejected the null hypothesis of homocedasticity and Woolridge test rejected the null hypothesis of serial correlation. However, evidence of cross section correlation (Pesaran test) was not found. Therefore, estimation with fixed effects (within groups) is shown with robust standard errors a *à la* White (1980) and *à la* Newey and West (1987).

Estimations show that growth rate of public investment per capita is correlated positively with the indicator of productivity of public investment and correlated negatively with the output per capita. Both coefficients are significant at 1% level.

Regarding the special needs criterion, the results suggest that public investment growth rate is positively related to the agglomeration of the economy since the coefficient of the population density is positive and significant at the 5% level. In addition, public investment growth rate is positively correlated with the GVA of the agricultural sector, the coefficient is significant at 1% level. This result makes sense since provincial governments were given competencies in this sector. However, public investment growth rate is negatively, although weakly, correlated with the GVA of the restaurant and hotel sector. The coefficient is significant at 10% level.

Regarding fiscal variables, striking results were obtained. It is shown the important role of the transfers to fund public investment of subnational governments. The coefficient is positive and significant at 1% level. In addition, strong evidence in favor of a positive relationship between fiscal decentralization and public investment growth

rate was found. Specifically, the coefficient of the proxy for financial autonomy is positive and significant at 1% level. This result goes above the same line of Faguet (1994) for Bolivia whose findings contradicted the "common claims that local government is too corrupt, institutionally weak, or prone to interest-group capture to improve upon central government's allocation of public resources". Morever, Porto, Pineda Mannheim and Eguino (2018) suggested that granting more autonomy to manage their own resources (taxes) to subnational governments in Latin America could boost efficiency and development at regional and country level.

Strikingly, no evidence for a relationship between political variables and the growth rate of public investment of the subnational governments was found.

The results for the estimation of the equation for the growth rate of current public spending per capita of subnational governments in Table 4.2 are described below.

Hausman test shows, again, evidence in favor of fixed effects. In addition, Green test rejected the null hypothesis of homoscedasticity and Woolridge test shows evidence of serial correlation. However, no evidence of cross section correlation (Pesaran test) was found. Therefore, estimations with fixed effects with robust standard errors *à la* White (1980) and *à la* Newey and West (1987). Again, it is noticeable the goodness fit since that the model is able to explain about 76 percent of the variability of the endogenous variable.

Similarly, to the growth rate of public investment per capita, the growth rate of current public spending per capita is correlated positively with the indicator of productivity of public investment and correlated negatively with the output per capita. Both coefficients are significant again at the 1% level.

However, agglomeration indicator is negatively correlated with the growth rate of current public spending per capita. The coefficient is significant at 5% level. Moreover, no other variable capturing special needs shows significant coefficient.

Regarding fiscal variables, again, strong evidence was found. Central transfers are positively correlated with the growth rate of current public spending per capita. The coefficient is significant at 1% level. The results for the variables that capture fiscal decentralization are striking. A positive and significant relationship at 1% level is found for the financial autonomy and the growth rate of current public spending per capita. However, it is negatively correlated with the proxy for the tax autonomy. The coefficient is also significant at 1% level.

Since the fiscal decentralization variables are of similar magnitude, a test for sum of each coefficient equals zero was carried out ($\beta_{10}^{c} + \beta_{11}^{c} = 0$). Table 4.2 shows that the hypothesis is only rejected at the 10% level with standard errors *à la* Newey and West. This result suggests that the positive correlation between financial autonomy the growth rate of current public spending per capita is counteracted by the negative correlation of the latter with tax autonomy. Therefore, it could be suggesting that, on the whole, fiscal decentralization is not related to the growth rate of current public spending per capita.

Different to the public investment growth rate, the growth rate of current public spending per capita do is related to political factors. Results show that the share of provincial right-wing MPs, as well as, majority of right-wing majors in provinces, are negatively related to the growth rate of current public spending per capita.

4.6. Conclusions

This paper has analyzed the allocation criteria of financial resources of the Ecuadorian subnational governments during the period 2001-2015. A theoretical model of public resource allocation was proposed to capture the traditional criteria established by the literature where: efficiency, equity or redistribution, special infrastructure needs and political factors. In addition, variables to capture decentralization were introduced. Panel data for the twenty-two Ecuadorian provinces were used.

Results suggest that the Ecuadorian subnational governments were able to deal with the efficiency-equity trade-off at allocating public spending. In addition, public investment of subnational governments seems to be allocated to mitigate the negative effects of agglomeration.

Finally, we can conclude, in general, that fiscal decentralization is related positively to public spending. Specifically, we have found that financial autonomy is correlated positively to the growth rate of public investment per capita. We have also found that financial autonomy is correlated positively to the growth rate of public current spending per capita financial. However, it seems to be counteracted by a negative correlation with the tax autonomy.

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Appendix 4.1 - Tables

Table 4.1.

Panel Data Regression of equation (21), Fixed Effects (within)

	Coefficients	**White SE**
$Ln\left(\frac{y_{jt-1}}{rc_{jt-1}}\right)$	0.8480	0.0485***
$Ln(y_{jt-1})$	-0.7414	0.0940***
$Ln(D_{jt-1})$	1.1153	0.4655**
$Ln(V_{jt-1})$	-0.0001	0.0409
$Ln(TC_{jt-1})$	0.0262	0.0312
$Ln(EI_{jt-1})$	0.0274	0.0986
$Ln(HI_{jt-1})$	0.2906	0.2108
$Ln(SA_{jt-1})$	0.1230	0.0385***
$Ln(ST_{jt-1})$	-0.0483	0.0270*
$Ln(tr_{jt})$	0.7116	0.1092***
$Ln(FA_{jt})$	0.2259	0.0586***
$Ln(TA_{jt})$	0.0078	0.0296
SR_{jt}	0.0497	0.0379
D_{jt}^{PR}	-0.0235	0.0213
D_{jt}^{MR}	-0.0001	0.0.312
R^2	0.7383	
H^{FR}	42.11 (0.0002)	
Green test	290.31 (0.0000)	
Wooldridge SC test	35.77 (0.0000)	
Pesaran CD test	-1.91 (1.9437)	
Friedman CD test	2.76 (1.0000)	

Notes: Number of observations: 255. Number of groups: 22. All variables in logs (except for dummies). *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 4.2.

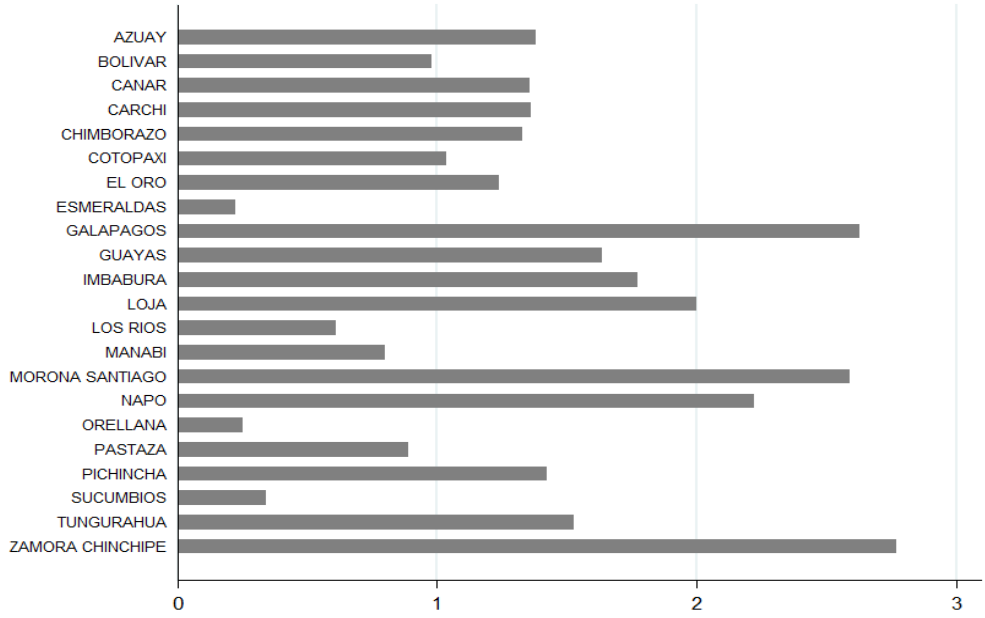
Panel Data Regression of equation (22), Fixed Effects (within)

	Coefficients	**White SE**	**NW SE**
$Ln\left(\frac{y_{jt-1}}{rc_{jt-1}}\right)$	0.8291	0.0763***	0.0667***
$Ln(y_{jt-1})$	-1.0986	0.1450***	0.1286***
$Ln(D_{jt-1})$	-1.1879	0.4765**	0.4797**
$Ln(V_{jt-1})$	-0.0321	0.0311	0.0325
$Ln(TC_{jt-1})$	0.0159	0.0434	0.0355
$Ln(EI_{jt-1})$	-0.1503	0.1295	0.1029
$Ln(HI_{jt-1})$	-0.0732	0.0401*	0.0511
$Ln(SA_{jt-1})$	-0.0278	0.0396	0.0479
$Ln(ST_{jt-1})$	-0.0155	0.0344	0.0260
$Ln(tr_{jt})$	0.5400	0.1117***	0.0948***
$Ln(FA_{jt})$	0.2527	0.0505***	0.0573***
$Ln(TA_{jt})$	-0.1255	0.0438***	0.0432***
SR_{jt}	-0.1212	0.0493**	0.0528**
D_{jt}^{PR}	0.0349	0.0274	0.0290
D_{jt}^{MR}	-0.0791	0.0376**	0.0277***
R^2	0.7584		
H^{FR}	40.40 (0.0004)		
Green test	1458.08 (0.0000)		
Wooldridge SC test	14.19 (0.0011)		
Pesaran CD test	-2.396 (1.9834)		
Friedman CD test	0.667 (1.0000)		
H_o: $\beta_{10}^c + \beta_{11}^c = 0$	2.87 (0.1048)		3.44 (0.0650)

Appendix 4.2 - Figures

Figure 4.1

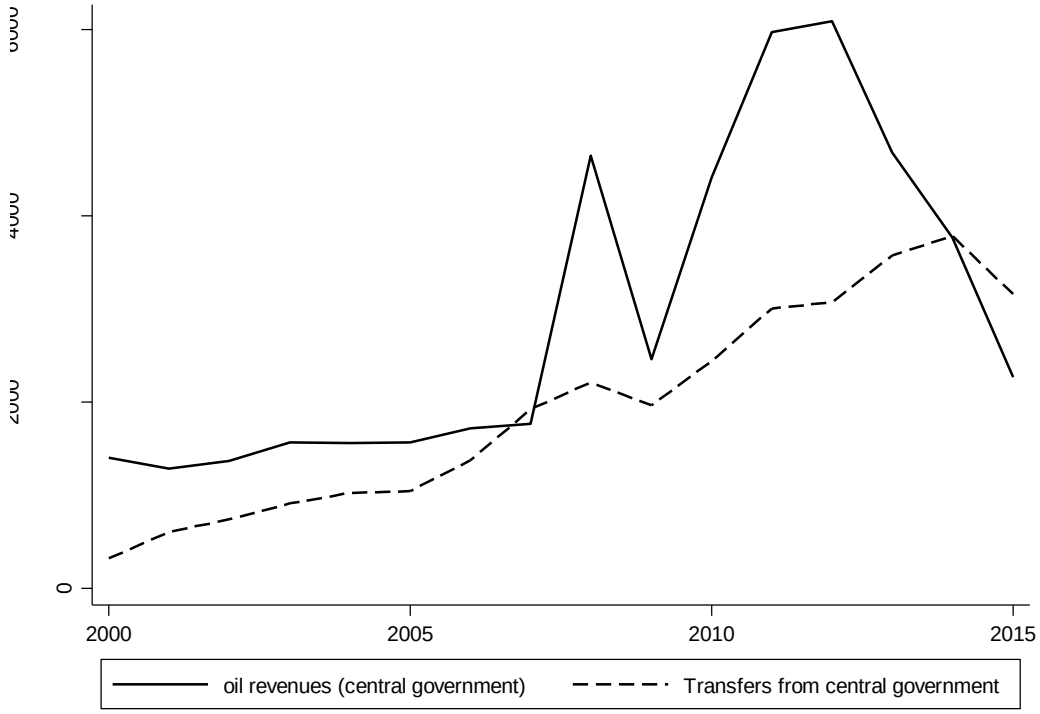
Own income of the provinces as a share of provincial Gross Value Added (GVA), 2001-2015



Source: Central Bank of Ecuador and Ministry of Economy and Finance.

Figure 4.2

Oil revenues and transfers to subnational governments, 2001-2015



Source: Central Bank of Ecuador and Ministry of Economy and Finance

Chapter 5
Conclusions

This doctoral thesis contains three essays on the Ecuadorian economy, both at the national and provincial levels. I analyzed some interesting economic aspect of this country, its most crucial stages, the events that, in some way, have shaped the characteristic instability of its economic growth and development and why, despite the booms in its raw materials, it still has a hard time developing the sectors least vulnerable to internal and external shocks. The availability of statistical information at the provincial and cantonal level allowed the analysis of the allocation of public spending, as well as its relationship with the decentralization process that the country has wanted to implement for decades.

The first essay analyzed the determinants of Ecuador's TFP in the period 1950-2014. A non-linear equation was proposed that relates the total factor productivity (TFP) with variables that can drive its growth. The results showed that both human capital and public infrastructure have had a positive impact on TFP, while the relationship between the general price index and TFP is negative. Furthermore, the results suggest that oil revenues have also had a positive impact on the country's economy due to the accumulation of productive factors. However, there is no strong evidence that oil prices directly affect TFP. Strikingly, during the stage in which the country implemented the ISI import substitution model, TFP shows a positive evolution, while during the period of the government of President Correa, there was a negative structural change.

In the second essay, the allocation of public resources by the Central Government of Ecuador to the provinces in the 2008-2015 period was analyzed. A theoretical model was proposed where public investment is managed according to three criteria: efficiency, equity and infrastructure needs. The results suggest that the central government managed to maintain a balance between the criteria of efficiency and equity, that is, the central government was able to make significant investments in those lagged provinces while no neglecting the most productive provinces. Regarding the criterion of infrastructure needs, the results suggest that the central government has tried to decongest some public services such as transportation and education. Political factors have also played an important role in the allocation of resources to the provinces since

the results show that those provinces where their parliamentary representatives belong to the same political party as the central government tend to be more favored. Another interesting finding is the possibility that there is an increase in public spending in the years before national or sectional elections are held.

In the third essay, the criteria for the allocation of public resources by subnational governments were analyzed. A resource allocation model is proposed capable of capturing the criteria of efficiency, equity, and special needs. For this, data at the provincial level from the period 2001-2015 were used. The analysis has also taken into account variables that control the effects of decentralization, a process that has taken the country many decades to implement properly, as well as political factors. The results indicate that the subnational governments of Ecuador have been able to manage public resources, complying with the criteria of efficiency and redistribution. Regarding the variables that capture fiscal decentralization, it was found a positive relationship between financial decentralization and the growth rate of public investment per capita. On the other hand, it is shown that the growth rate of current per capita spending is positively related to financial autonomy but negatively related to tax autonomy. A test suggests that the effects cancel out.

In summary, the three essays have realized that Ecuador's economy is highly dependent on oil prices in international markets, which has led it to experience several booms-bust cycles in the last sixty years. However, oil revenues have helped the country to carry out various investment projects in public infrastructure, as well as the implementation of programs and reforms that have encouraged the formation of human and physical capital that in the long term contribute to economic growth.

The centralization of the State, in addition to the transfers of financial resources to sectional governments that are pro-cyclical with oil exports, have been decisive for the decentralization process in the country but is still a pending issue, despite the efforts made by governments to give greater prominence to the provinces. In addition, there are provinces that do not have the capacity to generate their own resources and are highly dependent on state budgets.

Much remains to be analyzed regarding the Ecuadorian economy. One of the points that can be investigated further on are the effects of public investments made in various programs aimed at changing the country's productive structure since it was one of the main objective of the "*Buen Vivir" Plan*, as well as to study the convergence process of the provinces.