DOCTORAL THESIS

Business cycle, oil-related fiscal policy and political cycle: The case of Ecuador

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Declaration of Authorship

I, Igor Ernesto Diaz Kovalenko , declare that this thesis titled, "Business cycle, oil-related fiscal policy and political cycle: The case of Ecuador" and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

"I'm a great believer in luck, and I find the harder I work the more I have of it."

Thomas Jefferson

"Inspiration exists, but it has to find you working."

Pablo Picasso

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Contents

Chapter 1

Introduction

1.1 Theoretical framework, aim and scope

The study of business cycles has been an aspect that has focused much of the interest of economists, especially in the last years. The result of this interest has been the abundant literature that has emerged, and continues to emerge, on the subject. Historically, the cyclical behavior of the economy is a widely known phenomenon that has been studied since the beginning of mankind, first as a meteorological problem and later evolved scientifically with the emergence of economics as a science, interestingly it has suffered ups and downs. Even so, its importance is recovered through its capacity to understand how the different economic aggregates fluctuate and how volatile they are with respect to production, and it is also a fundamental tool in economic forecasting. Traditionally, macroeconomics relies on two types of models to explain the business cycles: long-term per capita GDP growth and fluctuations in production with respect to its growth trend.

Although this research is centered on issues of economic theory, the analysis of economic cycles includes a part of econometric analysis. It is important to understand that it is not possible to undertake an analysis of business cycles without being clear about a series of econometric concepts related to time series, so, in addition to the economic theory view of cycles, the statistical and econometric view of them is maintained. Econometrics enters into the thesis in two different ways. On the one hand, in the definition of the cycle, considering also the postulates of economic theory, and on the other hand, applying the most suggestive contrasts when trying to carry out a minimally formal evaluation of the models presented.

Real Business Cycles

Recurrent fluctuations in economic activity are common in both developed and developing economies; thus, different theories have attempted to explain this phenomenon with relative success. Modern business cycle theory establishes two basic objectives in business cycle research: the complete and systematic characterization of cyclical phenomena in the form of "stylized facts", and the construction of complete general equilibrium models that can be evaluated qualitatively and quantitatively in terms of their ability to reproduce these facts. This thesis is framed as an investigation of both objectives.

Capitalist accumulation is full of multiple potentially cyclical patterns (Shaikh, 2016). Thus, the starting point for the explanation of cyclical fluctuations comes from the Real Business Cycle model. The influential work of Kydland and Prescott

(1982) marks a turning point in the development of economic thought in several respects. The methodological revolution brought about by the Real Business Cycle Theory is based on three ideas: the first is that it is possible to study the cyclical phenomenon using Walrasian competitive general equilibrium models; the second is that it is possible to unify the explanation of the cycle theory with the theory of economic growth; the third is that we must go beyond making qualitative comparisons between the different theories and check whether the model is capable of explaining quantitatively the behavior observed in the economic series.

Models of real business cycle abstract from monetary phenomena. They are only interested in the behavior of real magnitudes (such as consumption, employment and investment), and do not answer questions related to nominal variables such as the price level or open market operations. They are characterized by the fact that no matter how monetary policy is conducted, the behavior of the quantities of goods and services will not be affected.

The line of research initiated by Kydland and Prescott (1982) is a special case based on the neoclassical growth theory literature with the addition of an endogenous labor supply and an endogenous labor market. Being the endogenous labor supply and technology shocks the generating and propagating mechanisms of cyclical fluctuations around a trend. The crucial elements of this theory rest on the assumptions that markets are competitive, that all information is public, and that technological shocks drive the economic system. These shocks are interpreted as the residuals of the production function that Solow (1956) identified. In turn, other assumptions are used, such as the existence of a representative consumer, the use of the techniques used by Kydland and Prescott are important to characterize the equilibrium.

In this way, the Real Business Cycle model explains the joint movements in the series based on the stochastic fluctuations of technological progress measured by the Solow residual. This explanation based on the changes that the production function undergoes when it is subjected to technological shocks contrasts radically with the literature in force until the early 1980s, which placed the change in monetary magnitudes as the most probable explanatory factor for the cause and origin of economic cycles.

Dynamic Stochastic General Equilibrium Model

Understanding the general economic reality has been a latent concern since Walras (1874) proposed an analytical method to study the interaction of agents and markets simultaneously, which gave rise to the theory of general equilibrium more than a century ago; lately, researchers have been interested in two aspects of economic reality, its dynamics, i.e. the intertemporal decisions of agents, and its uncertain nature, the innate uncertainty that comes from unpredictable human behavior, framed in its economic environment.

One of the major ambitions of economic theory is to come up with a theoretical model that explains the functioning of the economy in order to eventually be able to use it to evaluate alternative economic policies or to make forecasts. In 1976 "the Lucas Critique" (Lucas, 1976), stated that it is incorrect to try to predict the effects of a change in economic policy from the relationships observed in historical data,

especially when dealing with aggregate data. Up to that time, all the parameters of aggregate macroeconomic models that were estimated were not structural, since they were not invariable, and would therefore necessarily undergo alterations when economic policy changed. In other words, the Lucas Critique was a strong call to micro-founded economic models and to incorporate dynamic aspects into them.

In this direction, Kydland and Prescott (1982) developed the first complete Dynamic Stochastic General Equilibrium (DSGE) macroeconomic model based on microeconomic foundations, which assumed that technological changes were the generating forces of the growth and fluctuations observed in the post-war period in the United States. In other words, they demonstrated that many qualitative characteristics of real business cycles, such as comovements between macroeconomic variables and the relative variability of each of them, could be generated by a model based on supply (or technological) shocks.

As Christiano and Eichenbaum (1988) argue, the inclusion of the public sector has the potential to improve the predictions made by the aforementioned model: by considering only productivity shocks it is concluded that there is a high correlation between hours worked and the real wage, while the empirical data showed that this correlation is zero. This prediction error is due to the fact that the technology shock only modifies the demand for labor, but not the supply. In order to improve the predictions, these authors propose a Real Business Cycle (RBC) model, where they incorporate public spending in the utility function of the agents. Alternatively, Aschauer (1988) and Barro (1989) emphasized the importance of the response to fiscal policy shocks from the supply side, although the dynamic interactions of the labor-capital factor were strongly restrictive. Baxter and King (1993), who recognized and emphasized the importance of supply-side response, incorporated the role of the public sector in both the utility and production functions.

At present there has been an extraordinary advance in the application of mathematical, statistical and econometric techniques for the application of new macroeconomic models; this is due to the progress and development of computational tools at the service of economics. On this background it is emphasized that the DSGE models have acquired great importance in macroeconomic modeling. Given the nature of reality, the models are a fundamental tool for understanding the decisions of all agents simultaneously; eventual behaviors that occur around a macroeconomic variable and its interaction with the rest of the economy must be studied within a general equilibrium model to see how its development affects the performance of the economy as a whole. For a DSGE model to be correctly applied by decision makers, it is required that the economic theories are developed in a realistic way, and at the same time indicate the transmission process and the influence of the assumptions on the results. Therefore, they have become the main tool for the elaboration of public policies that aim at achieving medium and long term objectives.

Political Business Cycle

Based on the simple fact that voters care about economic performance and rulers care about achieving or maintaining power, the Political Business Cycle analyzes the interaction between the political system and the functioning of the economy. In other words, it points out that in election years, local leaders tend to show better results in order to increase the likelihood that their parties will remain in power,

and they do so by increasing investments in more visible areas, such as infrastructure, services, etc., in order to increase the likelihood that their parties will remain in power.

Heterogeneity and conflict of interest are essential parts of political economy. Consider that fight among the different interest groups for the common public resources as one of the causes that explain the procyclicality of fiscal policy in developing economies. Political decisions are often biased in favor of special interests at the expense of the general public, resulting in losses by the majority in excess of the gains by the minority. She argues that interest groups are better able to monitor incumbent activities and overcome the free-rider problem of costly monitoring, causing a policy biased in their favor.

In the literature, we find two large broad guidelines of the political business cycle theory: cycles generated by the government's economic intervention in the hope to be re-elected (opportunistic models) and the partisan view where the economic problems and policies are adopted in a different way, depending on the ideological orientation of incumbents' party. For the opportunistic model (Nordhaus, 1975), voters opt for the candidate who proposes the greatest benefit, analyzing the behavior of economic variables in the past, and the future proposal of the rulers in the case voters are rational. On the other hand, the partisan model Hibbs (1977, 1987) proposes a differentiation of the behavior and expectations of the agents, where the existence of irrational or market-adapted expectations, and rational ones, continue to exist.

1.2 Justification

Economic policies chosen by countries, as may be monetary, trade, tax, etc., have as their fundamental objectives price stability, sustainable growth, full employment, balance of payments viability, among others, and are often anchored in prior elaboration and analysis through econometric modeling. In this way, the evaluation of economic policy decisions is made in terms of the goals to be achieved in these areas, and what the bifurcations of such policies will be. It is at this point that the different business cycle models come into play, which make it possible to obtain a reliable economic model of the country, which is a fundamental tool for analysis. This type of study attempts to establish a historical analysis of the business cycle experienced in Ecuador, through the perspective of the real business cycle model and the political business cycle, allowing us to describe the relationships between the different economic agents that interact in the Ecuadorian economy.

This doctoral thesis can be justified by the need of a thorough investigation applying business cycle models in Ecuador, in order for these to be a close approximation to reality. Since this type of research is unprecedented in the Ecuadorian case, it constitutes an important contribution from theory and empirical evidence for the discussion and formulation of public policy. In short, this doctoral thesis contributes to the theoretical discussion and to the formulation of macroeconomic policies, based on the results obtained in the application of econometric models.

1.3 Chapters overview and publications

This thesis consists of five self-contained chapters leaving aside the introductory and the concluding remarks ones. Chapters from 2 to 5 can be read individually since they are either published or finished but not yet published papers. All papers were written jointly with my director Jose Luis Torres. Is important to indicate that all chapters revolve around the main theme of the thesis. Considering that, the structure is as follows:

Chapter 2 corresponds to a Systematic Literature Review paper published in the Migration Letters Journal.
The article uses an standard SLR framework to show the state of the art in business cycle research in Latin America by analyzing articles that use a variety of data, methodologies and approaches to measure the business cycle and convergence. Thus, this research focuses on two questions: whether business cycles become more similar over time and what factors drive business cycle synchronization.

Chapter 3 corresponds to a paper to be published in the European Journal of Futures Research journal.
The article provides a characterization of the business cycle in Ecuador using different methods of trend-cycle decomposition for the most relevant macroeconomic aggregates of the economy. The data used has an annual frequency for the period 1965-2020, and contains the analysis of the main productive sectors, components of aggregate demand and factor market of the Ecuadorian economy. The results obtained allow us to compare and analyse our empirical data in contrast with the theoretical assumptions. In short, this research shows the stylized facts of the Ecuadorian economy, hence revealing the main characteristics of its business cycle.

Chapter 4 corresponds to a paper to be published in the Eurasian Business Review journal.
The article studies the synchronization of the Ecuadorian business cycle with the countries of the Andean Community of Nations in two stages (1950-1994, 1995-2019) previous and a after the birth of the Andean Community of Nations. Thus, the research focuses on whether the business cycles with its neighbors have become more similar over time and assess the possibility of a monetary union based on the synchronization alone. Finally, the paper also studies the level of synchronization with its main international trading partners, confirming the Ecuadorian dependence on periods of economic expansion of its main trading partners to stimulate its level of economic activity.

Chapter 5 corresponds to a paper developed and finished during my doctoral stays in the University of Málaga and it is not yet published.
The article remarks on the macroeconomic consequences of oil price shocks for small oil-exporting countries like Ecuador with a adopted specific fiscal policy rule related to oil revenues. We focus on the particular case of Ecuador, where public investment is a function of oil revenues. By using a simple two-sector model featuring some key characteristics of the Ecuadorian economy, we study the effects of international oil price shocks on macroeconomic volatility and welfare. We argue that a slight modification of the current fiscal rule, by linking public investment to all government revenues and not only to oil revenues, would significantly reduce the volatility of

the Ecuadorian economy and cut the welfare cost of oil price shocks.

Chapter 6 corresponds to a paper developed and finished during my doctoral stays in the University of Málaga and it is not yet published.
The article evaluates the political business cycle in Ecuador for the period 1900-2020. Empirical evidence reveals that the reelection of the incumbent is an infrequent and rare event in Ecuador. Additionally, a large fraction of elected presidents do not complete the four-year term. To explain this evidence, the paper develops an imperfect democracy political model with voters and interest groups. Each group supports the incumbent depending on the quantity of public resource they receive, which depend on how total resources are split between the two groups and on the business cycle. The model predicts that the reelection of the incumbent is only possible in good economic times. This can be explained by the action of interest groups that greatly reduces the expected probability of reelection.

Chapter 6 provides some concluding remarks and future research agenda.

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Chapter 2

Business cycles in Latin American. A critical survey of empirical research

This paper develops a systematic literature review to show the state of the art in business cycle research in Latin America by analyzing articles that use a variety of data and approaches to measure the business cycle and convergence. Thus, this research focuses on two questions: whether business cycles become more similar over time and what factors drive business cycle synchronization. We conclude that business cycles in the Latin American region have gone through periods of both convergence and divergence, but that in general, evidence of a common business cycle in the region is limited. The level of synchronization varies across countries and sub-regions, and there are significant differences in the behavior of economies during recessions and expansions. Trade plays a crucial role in the propagation of the cycle, but the strength of synchronization between individual countries and the United States is unclear. In addition, the region's dependence on external events, particularly since the 2008 global recession, and the dominance of trade flows over financial flows are highlighted as determinants of business cycle comovements in the short term. Studies also suggest that Latin America's disconnection from advanced economies may be influenced by increased trade with China and the low degree of financial integration with its main partners.

2.1 Introduction

Since the beginnings of economic science, economists have studied the recurrent phenomena of boom and bust of economic activity, starting with Juglar (1862) who pioneered the study of economic crises and their relationship with economic cycles, followed by his Soviet counterpart Kondratieff (1935), who had conducted analyses of long economic cycles, analyses taken up by Schumpeter (1939). In the United Kingdom, it was Kitchin in 1923 who found evidence of the existence of a short business cycle.

Since then, the approaches and the depth of research have varied. Thus, both phases and comovements and common features of cycles have been the subject of study by economists of all schools of thought. On the phases of the business cycle, Mitchell (1913, 1927) highlighted the existence of expansions, recessions, contractions and recoveries throughout the cycle, while Kuznets (1926, 1930) noted the existence of some similarities between some economies throughout the business cycle. In relation to the comovements (contemporaneous, lagged or leading) between some economic variables, Mills (1936) pointed out the existence of correlations between

prices and quantities during economic expansions and contractions: correlations of positive sign between these variables were indicative of cycles induced by demand phenomena, while negative correlations were indicative of supply-induced cycles.

After the emergence of the Keynesian trend, with which income determination gained the greatest importance, discussions on the business cycle faded into the background and it was only until Lucas (1972, 1975) that the characterization of fluctuations, as well as the explanation of their causes, was taken up again with special interest. However, it has been during the last two decades that we have seen a greater development in the study and systematic measurement of economic fluctuations, which has provoked considerable macroeconomic debate. Some of this research has been assembled into a body of theory known as the Real Business Cycle (RBC) approach, initially proposed by Kydland and Prescott (1982) and Long and Plosser (1983).

Real Business Cycle models were originally designed to determine how much of the recurrent fluctuations in economic activity, measured in deviations of the logarithm of the variables around a trend or permanent component, could be attributed to real factors and, more specifically, to productivity shocks. So, we can say that business cycles are positions of GDP above and below potential GDP, i.e., they are non-periodic recurrent sequences of expansions and recessions. Since the "time to build" of Kydland and Prescott (1982), the use of the Hodrick and Prescott filter to separate the permanent and transitory components of a stochastic realization has become widespread (despite the multiple reactions that this filter has aroused). Other types of decompositions such as first differences, subtraction of a deterministic trend, whether linear or quadratic, or frequency domain techniques are also used to remove the permanent component of a variable.

Thus the description of the business cycle involves the measurement of the volatility of real output, employment, consumption, investment, prices, interest rates and monetary aggregates or, equivalently, the movements of these variables around their respective trend, the persistence of the cyclical component of these variables, as well as the co-movements of the cyclical component of all variables with that of real output. These three properties of the economic variables are observed in the transitory component of the variables and are estimated, respectively, by the standard deviation, the autocorrelation coefficient and the cross-correlation of the variables with real output. Accordingly, a variable is procyclical if its contemporaneous correlation with real output is positive; it is countercyclical if its correlation is negative; and it is acyclical if it is not contemporaneously correlated with real output in a significant way. Thus, for example, while countries in the downward phase of the cycle would prefer a more expansionary monetary policy, countries in the upward phase of the cycle would prefer a more restrictive monetary policy.

A variable leads (lags) output if its cross-correlation with future real output (lags) is higher than the contemporaneous correlation. The estimated indicators are used to identify the "regularities" or "stylized facts" associated with the business cycle, which, since Lucas (1977), constitute the underlying benchmark of Real Business Cycle models. These regularities, common to all decentralized market economies, are, first, procyclicality of prices, short- and long-term interest rates, monetary aggregates, measures of velocity of circulation and business profits; second, greater volatility in the production of durables (for both consumption and production) relative to that of non-durables; third, harmonic movements of output across sectors (conformity); and, finally, less harmonic movements in the production and prices of agricultural goods and natural resources.

It is for all these reasons that the analysis of economic cycles constitutes a useful tool for the design and evaluation of public policy. For this purpose, a systematic review of the vast literature developed under the approach of Business Cycles in Latin America was carried out, thus, the results obtained for different countries, periods, etc. presented by different authors are reviewed in order to address the central issue of this research: Can we speak of a convergence process in Latin American countries, are they synchronizing or, on the contrary, is there a more pronounced asymmetry over the years?

Within the literature on economic cycles, two points of view have been presented on this question. In what we call the "optimistic view", greater economic (and monetary) integration will lead to less divergence. This view is quite popular among policy makers in the European Union, for example. However, Krugman (1991) argues that if there is a similar concentration of industries in particular regions, because of economies of scale and scope, sector-specific shocks may become regional shocks, thus increasing the likelihood of asymmetric shocks and divergent business cycles. Thus, the "pessimistic view" holds that business cycles in the euro area may become more divergent in the future.

In the debate on the synchronization of business cycles in Latin America, there are two main points to be made. First, have business cycles in the region become more similar and, second, what factors drive business cycle synchronization? On the first issue, the literature has not yet reached a consensus on whether the business cycles of the region's countries are converging. Differences among various studies can be partly explained by the use of different data. However, other reasons include the use of divergent methods for identifying business cycles and assessing convergence. Competing methods have been suggested for calculating a business cycle. There is also no consensus on how convergence between business cycles should be measured. Regarding the second issue, several factors that can affect the timing of the business cycle have been raised, ranging from trade relations (Frankel and Rose, 1998), specialization (Imbs, 2004), monetary integration (Fata's, 1997), financial relations (Imbs, 2006) and fiscal policy (Clark and van Wincoop, 2001). However, despite the theoretical and empirical analyses to date, it seems fair to say that there is no consensus on the important determinants of business cycle comovement. The difficulty is that there are many possible explanations.

This paper reviews the empirical literature dealing with these issues, focusing on Latin American countries. This implies that papers on business cycle asymmetries among G7 countries (such as Kiani and Bidirkota, 2004) or on international business cycles (such as Ambler et al., 2004) are not discussed, unless they contain interesting results from the point of view of the present paper. The rest of the paper is organized as follows. Section 2 describes the methodology used to select the articles. Section 3 reviews the methods for identifying business cycles and business cycle timing. Section 4 assesses the degree of business cycle synchronization in the region, as well as analyzes the factors that drive synchronization. The last section offers some concluding remarks.

2.2 Description of the methodology for article selection.

The transfer of knowledge through scientific publications is considered a fundamental element for the advancement of any science (Pérez-Anaya, 2017). This advancement requires that researchers know the state of the art in the subjects studied. In this context, it is valuable to perform a qualitative analysis, previously requiring a

quantitative study of the academic literature on a topic (Fernández, 1998). Starting from the research questions, which are: have the economic cycles in the region become more similar and, secondly, what factors drive the synchronization of the economic cycle?

The search strategy comprised the search terms, the literary resources and the search process, which took place in November 2020. The main concepts in Spanish and English referred to in the research questions were used. These are synchronization, economic cycles, Latin America was also included because the focus of the research is this region. It is important to identify different ways of writing the terms, including abbreviations and synonyms. Specifically, the sources for the literature review were the databases Web of Science, Scopus, Directory of Open Access Journals, JSTOR and SciElo. In addition, additional potential articles were identified by searching the academic search engine Google Scholar. This search procedure is widely accepted and has been used by (David and Han, 2004; Hohenstein et al. 2014; Kitchenham et al. 2010; Turner et al. 2010).

With the purpose of selecting interesting papers in this study, we proceeded to apply the inclusion and exclusion criteria to them, and subsequently the quality assessment through the quality criteria as already done by authors such as Kitchenham et al. (2010). Once the key words had been included and the articles that would form the basis of the work for this study had been obtained, the studies were filtered by applying inclusion and exclusion criteria. Specifically, and following Echeverri and Cruz (2014) and Ramírez Correa and García Cruz (2005), all those scientific articles (1) with a publication date after 2000, (2) published in Spanish and English, (3) articles published in scientific journals, (4) primary studies and (5) with business cycle methodology in Latin America were retrieved. Similarly, the main exclusion criteria were established, which led to the rejection of all papers (1) of less than four pages, (2) those published as theses and books, and (3) those that were duplicates. The papers were classified according to the type of study and a generic set of questions was used to assess their rigor, credibility and relevance, and thus make the final sieve to obtain the final sample. This quality instrument was developed by Dybå and Dingsøyr (2008) in their systematic review on software engineering, and is applicable to most studies.

2.3 Measuring business cycle synchronization.

Studies examining business cycle synchronization in the Latin American region tend to reach very different conclusions. Part of these differences may be related to the selection of variables used, divergent methodologies for constructing business cycles and alternative ways of assessing synchronization. Therefore, we start from a description of the methodology used to collect the information to be analyzed in this paper in the previous section, and then discuss the economic variables that have been considered, alternative ways of measuring the cycle and different indicators of business cycle synchronization.

2.3.1 Data used.

The two most important variables used are annual data on real GDP and monthly data on the industrial production index (IPI). In addition, GDP per capita, adjusted as purchasing power parity to U.S. dollars, is sometimes used. From the perspective

of this paper, studies on business cycle synchronization should focus on the broadest possible output variable, i.e. GDP at a quarterly frequency and generally, annual data would be avoided in order to capture more high frequency fluctuations, however, unfortunately in the Latin American case the absence of long-run databases at shorter frequencies does not exist in the long run.

IP data has the advantage that it is available for many countries on a monthly frequency. However, the conceptual reasoning behind the use of the PI is less convincing. First, manufacturing activity is less representative in Latin America compared to Europe or the United States, so a priori it would not appear to be representative of total production. Second, manufacturing output is much more volatile than aggregate output.

2.3.2 Business cycle measurement.

A first distinction to be made is between classical business cycles and deviation (or growth) cycles, i.e. the difference between the cyclical and trend component of a time series. Burns and Mitchell (1946) define (classical) business cycles in terms of absolute expansions and contractions of economic activity. More recent business cycle studies, however, analyze deviation cycles, i.e. the deviation of economic activity from a "trend". This is also true for most of the studies analyzed here. One practical reason why most researchers focus on deviation cycles is that most of the (parametric) measures used to describe the cycle need stationary series as input. Also, since most economies are growing over time, classical recessions occur much less frequently than growth cycle recessions.

The studies discussed in this paper use a variety of filtering techniques to decompose the output into trend and cycle. The simplest filtering technique is to calculate first differences . This is usually sufficient to make the series of interest stationary. However, as Baxter and King (1999) point out, first differencing removes a trend from a series, but potentially at the cost of a shift in the peaks and valleys of the differenced series and increased volatility. The phase shift may not be too important when comparing cycles across countries, as this phase shift is the same for both countries. However, the greater weight on the higher frequencies of the series emphasizes irregular "noise" over cyclical movements.

Most of the studies under review apply non-parametric filters, especially the Hodrick-Prescott filter (1997), the Baxter-King bandpass filter (1999) and the phase average trend (PAT, Boschan and Ebanks, 1978) using the Bry-Boschan algorithm. Probably the most commonly used filter in this type of research is the Hodrick-Prescott (HP) filter. This filter estimates the trend component by minimizing deviations from the trend, subject to a predetermined smoothness of the resulting trend. The HP filter can be interpreted as a high-pass filter that removes fluctuations with a frequency of more than 32 quarters or eight years and places those fluctuations in the trend .

Baxter and King (1999) argue that the combination of a high pass filter on the one hand and a low pass filter (which removes high frequencies) on the other hand is better since the HP filter still leaves much of the high frequency noise as part of the cycle. If such a bandpass (BP) filter is applied, the resulting cyclic component does not contain any jitter with high or low frequencies beyond the predetermined cutoff points. Both Baxter and King (1999) and Christiano and Fitzgerald (2003) derive an approximate BP filter using somewhat different assumptions.

Finally, the PAT is closely related to the method used to calculate business cycle turning points. The PAT filter, originally proposed by Boschan and Ebanks (1978),

begins by estimating a 25-quarter moving average. Inflection points for deviations from this trend are dated using the Bry and Boschan (1971) algorithm, which generates classical cycle turning points that closely approximate those selected by the NBER Business Cycle Committee. Finally, the trend is estimated by connecting the mean values between each cyclical peak. Zarnowitz and Ozyildirim (2002) show that the PAT filter gives inflection points similar to other filters such as the HP filter and the Baxter-King BP filter.

2.3.3 To what extent does the selection of a particular way of modeling the business cycle affect conclusions about the timing of the business cycle?

Unfortunately, only a few studies test how sensitive their results are in this respect. Within this research Fiess, N. (2007) and Avila et al. (2015) conclude that the use of the various filtering techniques in their investigations did not lead to differences in the final results. Similarly Artis and Zhang (1997) and Calderon et al. (2007) conducted analyses using various filtering techniques (PAT, HP, linear trend, quadratic trend, first differences, BP) for OECD countries and 147 countries around the world respectively; both concluding that the choice of a particular filtering method is not crucial for their conclusions. Like Massmann and Mitchell (2004, p. 303), who considered a large number of business cycle measures, they concluded that "there are substantial similarities between alternative measures of the business cycle."

This finding is noteworthy since Canova (1998) concluded that different filtering methods lead to divergent conclusions regarding the U.S. business cycle. However, these findings are not mutually exclusive, as Canova compares the results of applying different filters to a country's output, while Massmann and Mitchell et al. compare results using different filters across countries. So, although different filters may "extract different types of information" (Canova 1998, p. 475), the findings are similar when comparing this information across countries.

In summary, studies using standard filters such as the HP, Baxter-King, and Christiano-Fitzgerald filters are likely to yield similar results. These three filters also work reasonably well for isolating fluctuations in the data at certain frequencies, which after all is the most important objective of filtering. The use of the first differences is likely to lead to major problems, as it places too much weight on high frequency fluctuations.

2.3.4 Synchronization Measurement.

Given a certain measure of the business cycle, one has to determine the extent to which these cycles move together across countries. Most studies use simple (Pearson's) correlation coefficients of the cyclical part of GDP for this purpose, but others have suggested alternative measures in the literature, such as Harding and Pagan's (2002) concordance index and Bernard and Durlauf's stochastic definitions of convergence.

The concordance index proposed by Harding and Pagan (2002) is a nonparametric comovement measure using a binary indicator variable of recessions and expansions. This index measures the percentage of time that the two series are in the same phase of the business cycle. The index is in some ways more flexible than the correlation coefficient, since any method can be chosen to distinguish between recessions and expansions. Thus, while the correlation between GDP series is calculated, the levels will generally not be very informative due to the strong trend in those series,

classical recessions can be dated from these level series and the matching index can be calculated. However, one drawback is that the analysis of a binary variable yields potentially useful information.

For their part, Bernard and Durlauf's (1995) definitions of convergence imply that, if the output series are trend-stationary, the time trends should be the same between countries i and j. This choice is taken into account when assessing convergence as the absence of unit roots. In particular, stochastic definitions of convergence and common output trends, which can be tested naturally using cointegration techniques, are based on Bernard and Durlauf (1995). Unlike classical tests that only tell us whether convergence has occurred in a given period, this approach also confirms whether convergence is a continuous process. This additional advantage is important for the embryonic South American case examined by Bolaños, A. (2017) because convergence is still in the process of occurring. According to Bernard and Durlauf (1995), for countries to converge, the long-run forecast of their output gaps must tend to zero. Thus, if the standard of living of two (or more) countries converge, the output gap between them will tend to disappear in the long run.

Most measures of comovement are judged by their characteristics and not so much by economic reasoning. An exception is the work of Kalemli-Ozcan et al. (2001), who argue that a natural measure of asymmetry quantifies the potential welfare loss due to asymmetric GDP fluctuations in the absence of risk-sharing mechanisms.

The final problem to be discussed is how to judge the change in comovement between cycles over time. The simplest solution is to compare correlations in two periods, for example, before and after the establishment of the Exchange Rate Mechanism (ERM) (Artis and Zhang, 1997, 1999), or for multiple periods as in Inklaar and De Haan (2001) and De Haan (2002, 2008). A more general and less arbitrary approach is to use moving windows as in Massmann and Mitchell (2004). The use of a correlation coefficient as the dependent variable in models examining the determinants of business cycle timing leads to some complications. Since the dependent variable lies between 1 and 1, the error terms in a regression model of the determinants of business cycle synchronization are not likely to be normally distributed. In fact, the evidence presented by Inklaar et al. (2007) suggests that it is necessary to transform the dependent variable.

2.3.5 Measurement of synchronization: "Accounting for shocks".

All the measures discussed so far take business cycles for granted. A different variety of literature seeks to directly classify fluctuations as originating, for example, from common shocks or country-specific shocks, as Caporale et al. (2015) do. Clark and Shin (2000) review the literature using vector autoregression (VAR) models or factor models to identify the sources of fluctuations. Thus, said authors establish that shocks in industry i of country c can be decomposed into common shocks (a), country-specific shocks (b), industry-specific shocks (c) and idiosyncratic shocks (u). Alternatively, studies estimate models using data on industries within regions of a country (e.g., Norrbin and Schlagenhauf, 1996; Clark and Shin, 2000).

The most common identifying assumption in these models is that the various shocks are uncorrelated. This means that an industry-specific shock at time t is a shock to that industry in all countries, but not to other industries. Clark and Shin (2000) argue that, although this is restrictive, it can be seen as providing a lower bound on the significance of industry- or country-specific shocks. A more conceptual problem with this type of model is that economic theory is relatively silent on

the sources of the identified shocks. For example, it seems plausible to attribute industry-specific shocks to changes in product demand and productivity shocks, but more definitive statements cannot be made in the absence of an economic model.

This method seems a complement to the methods described above for observing common cyclical movements across countries. In a sense, the correlation between cycles is a "crude" measure of comovement, capturing all commonalities, regardless of the source of the shock, as well as the policy reaction to the shocks. The literature on shock accounting attempts to take this a step further by deriving a "net" measure of comovement. This measure includes only shocks that occur across countries and industries, and excludes the contribution of industry-specific shocks. From a policy point of view, the gross measure is probably more interesting, as it gives an indication of how appropriate a common monetary policy will be. However, the literature on shock accounting provides additional information.

2.4 Synchronization of the economic cycle in Latin America.

Studies on business cycle synchronization in Latin America use different data sets and approaches to measure the business cycle and convergence, the main aspects and results of which are summarized in Table 1 and are broken down and elaborated below:

2.4.1 Data used.

Regarding the data used, time series of macroeconomic variables such as real Gross Domestic Product (GDP), the Index of Industrial Production (IPI) and GDP per capita are mainly used. These data are collected on a quarterly or annual basis and cover different periods, from the 1950s to the present. The studies also consider international trade and capital flow data to analyze the influence of economic integration on the timing of cycles.

2.4.2 Measurement of the cycle and convergence.

Among the approaches used to measure the business cycle, different methods are employed, such as the Hodrick-Prescott filter, the Bry-Boschan algorithm and the Harding-Pagan algorithm. These approaches make it possible to identify the cyclical movements of economic variables and to determine the duration and amplitude of the cycles. Finally, as regards the measurement of convergence, different techniques are used, such as Pearson's corrected contingency coefficient, the correlation coefficient and the generalized variance error estimation (GFEV). These measures make it possible to assess the convergence of business cycles between countries and to determine whether there is a trend towards synchronization or divergence.

2.4.3 Trade as a convergence mechanism.

Trade plays a crucial role in the propagation of business cycles in Latin America. Greater trade integration between countries can lead to the transmission of shocks and the synchronization of business cycles.

In this regard, a study by Caporale and Girardi (2015) found that trade is a cycle propagation mechanism among Latin American countries. The study suggests that trade flows between countries can transmit shocks and contribute to the synchronization of business cycles. Similarly, a study by Fiess (2007) on Central America

TABLE 2.1: Studies on the Synchronization of Economic Cycles in Latin America

Authors	Data	Common Business Cycle in LATAM?
Ávila-Vélez, Et al. (2015).	IPI. 1980-2014	Yes
Bolaños, A., Et al. (2017).	GDPpc. 1951-2011	No
Caporale, G., Et al.(2015).	GDP. 1980-2011	No
Fiess, N. (2007).	IPI. 1965-2002	No
Gong, C., Et al. (2018).	GDP. 1990-2009	No
González, G., Et al. (2012).	GDPpc. 1960-2008	No
Martínez-Roldán, L., Et al. (2012).	GDP. 1960-2008	No
Mora-Mora, J. (2016).	ECI. 1980-2014	Yes
Rendón, A., Et al. (2010).	GDP. 1960-2008	No
Reyes, P. (1999).	GDPpc. 1950-1995	No
Salamanca-Lugo, A. (2012).	GDP. 1961-2007	Yes

concluded that trade integration within the region has the potential to synchronize business cycles. The study underscores the importance of trade linkages in transmitting shocks and influencing the co-movement of economic activity. In addition, a study by Gong and Kim (2018) on emerging and developing countries, including several Latin American countries, also emphasizes the role of trade integration in synchronizing business cycles. The study suggests that regional or global integration, particularly through trade, can lead to a higher degree of business cycle synchronization. Taken together, these studies highlight the important influence of trade on the propagation of business cycles in Latin America, and increased trade integration contributes to the synchronization of business cycles among countries in the region.

2.4.4 Has there been convergence in Latin American business cycles?

Studies generally conclude that there is not a high synchronization of business cycles among the countries of the region. However, greater synchronization is observed in subregions such as Mercosur, and trade plays a role in the propagation of business cycles. The importance of financial and trade links with countries outside the region in the synchronization of business cycles is also highlighted.

Thus, the studies conclude that there is limited evidence of a high level of business cycle synchronization among Latin American countries. Among the most representative findings, the study by Fiess (2007) on Central America found limited evidence of a common business cycle in the region. Another study by Salamanca Lugo (2012) on Colombia, Ecuador and Venezuela also found little evidence of a common business cycle. In addition, a study by Caporale and Girardi (2015) on Argentina, Brazil, Chile, Mexico, Peru, and Venezuela concluded that, while trade plays a crucial role in the propagation of the cycle, the strength of synchronization across countries and the United States is unclear.

Overall, the studies suggest that while there may be some synchronization of business cycles in Latin America, it is not strong or consistent across the region.

2.5 Conclusions

The studies analyzed on the synchronization of business cycles in Latin America use a variety of data and approaches to measure the business cycle and convergence. These approaches make it possible to analyze the influence of trade and economic

integration on the propagation of cycles and to determine whether there is strong or limited synchronization among countries in the region.

Studies on the synchronization of business cycles in Latin America generally conclude that there is limited evidence of a common business cycle in the region. The level of synchronization varies between countries and sub-regions, and there are significant differences in the behavior of economies during recessions and expansions. Trade plays a crucial role in the propagation of the cycle, but the strength of synchronization between individual countries and the United States is unclear. In addition, the region's dependence on external events, particularly since the 2008 global recession, and the dominance of trade flows over financial flows are highlighted as determinants of business cycle comovements in the short term. Studies also suggest that Latin America's disconnection from advanced economies may be influenced by increased trade with China and the low degree of financial integration with its main partners.

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Chapter 3

Characterization of the Ecuadorian Business Cycle

This paper provides a characterization of the business cycle in Ecuador using different methods of trend-cycle decomposition for the most relevant macroeconomic aggregates of the economy. The data used has an annual frequency for the period 1965-2020, and contains the analysis of the main productive sectors, components of aggregate demand and factor market of the Ecuadorian economy. The results obtained are in full agreement with the theoretical assumptions, among the most significant are the following. First, the cyclical component of both the GDP of the primary sector and the oil sector shows high volatility due to the Ecuadorian economic structure, which causes cyclical fluctuations in Ecuador to be significant. Second, the volatility of consumption is higher than that of GDP, which is evidence of deviations from the life-cycle hypothesis explained by the existence of rigidities in the credit and labor markets that cause consumption to vary significantly in response to changes in income. Third, public spending shows a very high relative variability, as well as a procyclical and coincidental behavior with economic activity. It is therefore an automatic mechanism; whereby public spending increases when public revenues are higher and decreases when public revenues fall. Finally, employment is less volatile than economic activity, which leads to procyclical behavior in labor productivity.

3.1 Introduction

The study of business cycles has its origins in the pioneering work of Burns and Mitchell (1946). Subsequently, two of the works that have had the greatest impact and became important references are those of Lucas (1977) and Kydland and Prescott (1990). These initial works have given rise to an extensive literature, both theoretical and empirical, focused on the study of cyclical fluctuations, which have become one of the main topics of macroeconomic analysis.

Business cycles are defined as fluctuations in economic activity around a trend that indicates its long-term path. A business cycle can be characterized by different phases. For this reason, it is important to determine the causes of these fluctuations, as well as the interrelationship between the main macroeconomic variables according to their short- and medium-term dynamics. One of the main characteristics of the business cycle is that the fluctuations observed in the level of activity do not present any regular pattern, making it complex to determine the duration and amplitude of these movements. This means that the different cyclical phases through which an economy passes do not have a similar duration nor are they homogeneous, although they tend to repeat themselves over time. The cyclical behavior of economies

is a widely known phenomenon, although there is still not adequate knowledge of the facts that produce it, nor of its propagation mechanisms. Interest in the study of cyclical fluctuations in the economy has fluctuated over time, as has its own behavior. Thus, there have been periods in which economists were very interested in the business cycle and it was the fundamental research topic, with periods in which there has not been the slightest interest in its study, either because they were not considered relevant or because the economy showed great stability.

In the empirical study of business cycles, the first problem is how to obtain the cyclical component and separate it from its trend component. The problem is that, depending on the method used, the cyclical characteristics identified for the different series may vary. (Canova, 1998). Traditionally, cycle and trend were analyzed separately. Thus, cyclical fluctuations would simply be short-term deviations from a deterministic long-term trend. This view was abandoned after the important work done by Nelson and Plosser (1982), who analyzed the nature of a set of macroeconomic time series and could not reject the existence of a unit root in most of them, in this sense, the first theoretical developments of the real business cycle (RBC), which were motivated by the results obtained by Nelson and Plosser, were carried out by Kydland and Prescott (1982), Long and Plosser (1983), King and Plosser (1984) and Hansen (1985). These authors work with the idea that shocks and fluctuations in real variables were caused by persistent real supply shocks associated with technological progress. These shocks generate fluctuations in relative prices to which rational agents respond through their intertemporal choices. The main policy implication derived from this approach is that the existence of fluctuations in the level of output does not imply that markets are not in equilibrium, so the government should not attempt to reduce these fluctuations through stabilization policies.

Certainly, the study of cycles is an analysis of undoubted interest for a wide range of reasons, and it is also a key element in economic forecasting. In the first place, it allows us to obtain a measure of fluctuations over time, making it possible to know how the different variables move with respect to the cycle behavior of the level of production, as well as the degree of correlation between them. Secondly, the study of the cycle makes it possible to weigh the degree of volatility shown by the dynamics of the different macroeconomic aggregates, in relation to the variability shown by the level of production. This analysis can be of great importance since, for example, by measuring the volatility of the cyclical component of consumption with respect to that of the level of production, we can infer the validity of the permanent life-cycle hypothesis. This analysis is also of great importance in terms of the study of the labor market, by determining how movements in the level of employment and labor productivity are during the different phases of the business cycle. Thirdly, because of its interest for economic forecasting, the analysis of the cycle makes it possible to identify leading indicators. In this sense, one of the main challenges of economic forecasting is to anticipate changes in the phases of the cycle. These leading indicators can be very useful for detecting changes in the behavior of the economy in the short term.

The structure of this paper is as follows. In the second section we describe the sources used to collect data, as well as the methodology used. The third section describes and applies the different methods used to obtain the trend component to a set of series of the Ecuadorian economy, in order to analyze the relationship between the cyclical component of the different sectors and the Ecuadorian economy as a whole through the study of their volatility, correlations and comovements. Finally, the fourth section presents the most relevant conclusions that can be drawn from the results obtained.

3.2 Design and approach

In this paper we perform a characterization of the cycle of a set of aggregates of the Ecuadorian economy for the period 1965-2020 in order to characterize the business cycle in Ecuador. The key element in this type of analysis lies in identifying the cyclical component and trend of a time series. In order to perform this decomposition, we will apply a variety of filters to a small but sufficiently representative set of macroeconomic variables in the selected series. The cycle of the different series will be studied in relation to the cyclical behavior of the GDP. The ultimate objective is to offer a set of facts about the short- and medium-term behavior of the Ecuadorian economy.

In the literature we find a wide range of examples of this type of analysis: among many examples, those carried out by Danthine and Girardin (1989) for Switzerland, Kydland and Prescott (1990) for the United States, Blackburn and Ravn (1992) for the United Kingdom, Englund, P., Persson, T. and Svensson, L. (1992) for Sweden, Fiorito and Kollintzas (1994) for the G-7 countries, Christodoulakis, N., Dimelis, S., Kollintzas, T. (1995) for EU countries, Bjornland (2000) for Norway, and Dolado, Sebastián and Vallés (1993), Puch and Licandro (1997), André and Pérez (2005) and Bongers, Torres and Rodríguez-López (2010) for the Spanish economy.

The analysis we are going to perform uses different statistical procedures to study the cyclical behavior of the Ecuadorian economy. A battery of decomposition filters is applied to extract the cyclical component of each variable, which will allow us to characterize the business cycle in Ecuador. These cyclical components are used to study the volatility and comovements of the different variables.

The series we are going to use are the main ones of an economy, distributed as follows: GDP by productive sector, aggregate demand components, and factor market. The series we are going to use for reasons of data availability and extension of the series have annual frequency and the sample period used is from 1965 to 2020. Used data come from the Central Bank of Ecuador database complemented with the Penn World Table v. 10 database and the World Bank database.

3.3 Results

3.3.1 Stylized facts of the Ecuadorian economy 1965-2020

A relatively small number of studies of this type have been carried out for the Ecuadorian case. Among them Gachet, I., Maldonado, D., Oliva, N., & Ramirez, J. (2011), Orellana, M. (2011) and Kovalenko, E. D., Pérez, M. A., & Núñez, L. B. A. (2019) who analyze this issue through the RBC methodology and stochastic dynamic general equilibrium models. In general terms, these authors obtain very similar results in terms of the characterization of the main characteristics of the Ecuadorian business cycle, behavior that is also similar to other Latin American countries. Among the most outstanding results we find that the behavior of household consumption is highly procyclical and volatile. Government spending is also procyclical and slightly more volatile than household consumption. Additionally, investment is very volatile in relation to GDP, although highly coincidental with the level of output, and finally, the unemployment rate is countercyclical.

In this paper we will try to deepen the analysis carried out by the previous authors in order to contrast and extend the results. For this purpose, the series we are going to use in this paper are the main series of an economy: GDP, GDP by sector, Oil and non-Oil GDP, Consumption, Investment, Public Expenditure, External

Sector, Economically Active Population, Employed Population, Unemployed Population, Labor Productivity and Capital Productivity.

Figure 1 shows the series used in our analysis. As we can see, all macroeconomic series show growth over time, except for the unemployed population. This secular component can be represented by a positive trend, except in the case of unemployment, which shows a negative trend during the period analyzed. However, we see that this growth is not sustained, as there are significant deviations from a linear trend, which can be observed in variables such as investment or capital productivity, in addition to those corresponding to GDP by sector. These deviations are precisely representing the cyclical fluctuations through which the economy is passing. In order to study its cyclical behavior, it is first necessary to extract this component from the series, separating it from the trend component.

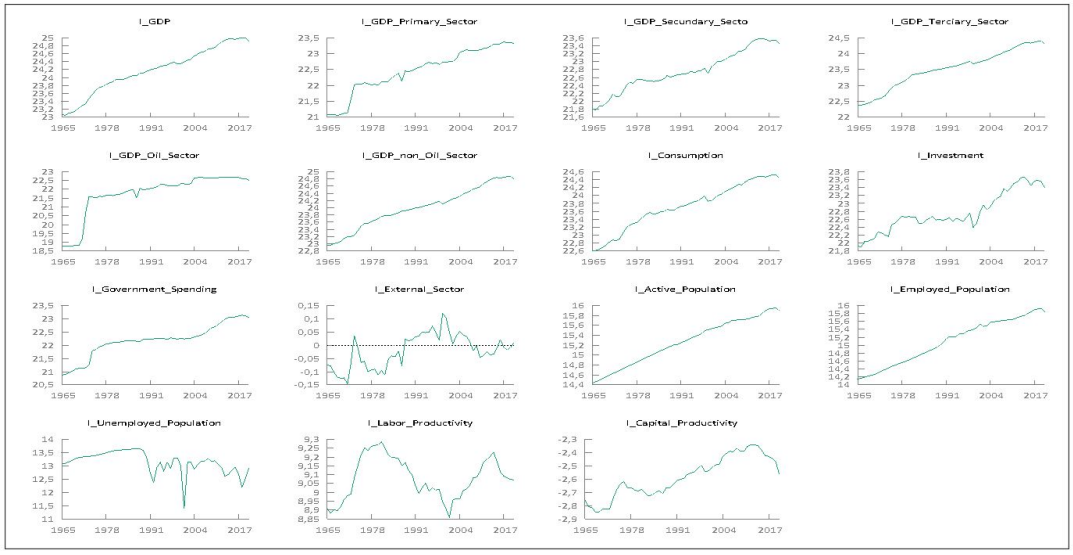

Figure 1: Original Series (logarithmic values)

Figure 2 shows the Ecuadorian GDP along with a linear trend. As we can see, the level of production of the Ecuadorian economy shows an increasing trend, but with deviations from a linear trend caused by some periods in which there has been a decline in the level of production. Specifically in this figure we can observe three particularly significant moments in which the level of production is below its linear trend: in the period 1965-1972, in the period 1998-2005 and from 2016 onwards. However, this way of extracting the cyclical component would result in recession periods that are too long and would only be valid if the trend growth of the economy were truly linear and do not reflect the cyclical movements of the economy. For this reason, we will study the cyclical component of the economy using a wide variety of filtering methods.

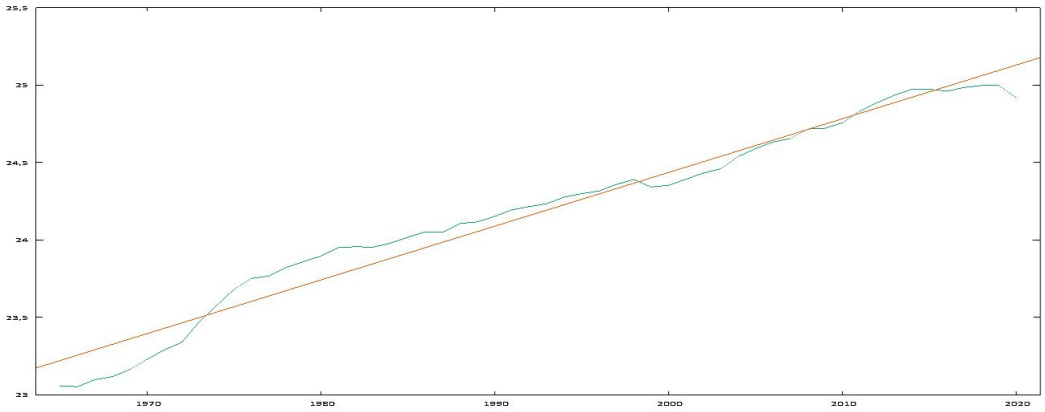

Figure 2: Ecuadorian GDP and linear trend

Figure 3 shows the year-on-year growth rate of the Ecuadorian GDP, a transformation that allows us to appreciate more easily the cyclical movements. In fact, the calculation of the year-on-year growth rate already implies the application of a filter to the time series and can be in some cases a good approximation of the cyclical component.

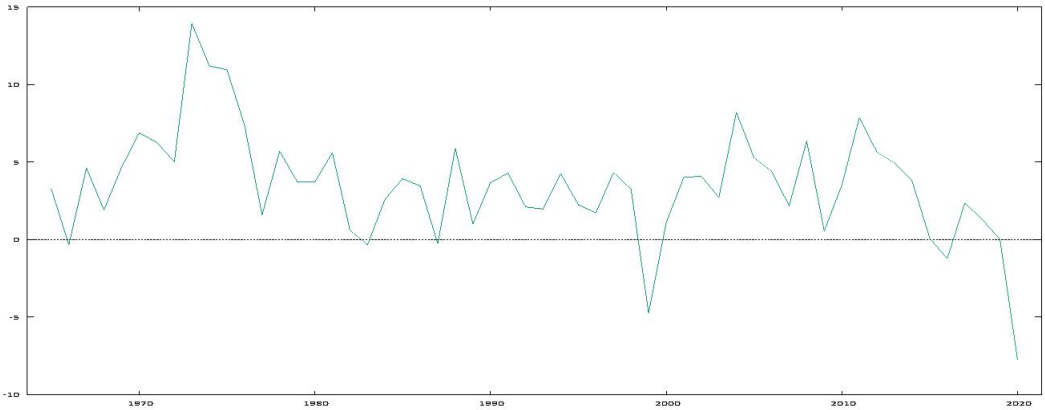

Figure 3: Interannual economic growth rate of Ecuadorian GDP

3.3.2 The cyclical component

To extract the cyclical component of the variables we will apply the five most common filters in cyclical component analysis for each of the macroeconomic series of the Ecuadorian economy. These filters are the most used in the literature and were developed by: Hodrick, R.J. and Prescott E.C. (1997), Baxter, M. and King, R.G. (1999), Christiano, L. and Fitzgerald, T. (2003), Beveridge, S. and Nelson C.R. (1981) and Butterworth, S. (1930). They will be represented respectively by the following acronyms: HP, BK, CF, BN and BW.

Figure 4 shows the cyclical component of GDP obtained from the different filters used. As we can see, there are important differences with respect to the cyclical component of GDP depending on the filter used, especially in the case of the Beveridge-Nelson filter. However, they all show a similar pattern of behavior in the long term, although in the short and medium term the fluctuations are different. We note that there are filters that obtain a very similar cyclical component, for example, the CF, BK and BW filters.

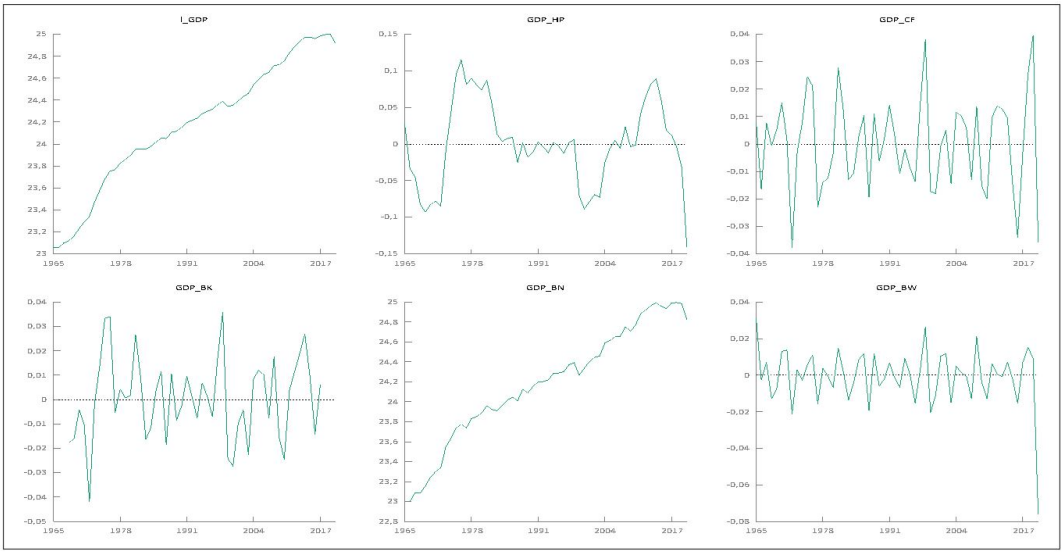

Figure 4: GDP Cyclical Component according to each decomposition filter

Figure 5 shows the cyclical component of the variables according to the results provided by the HP filter with *Lambda* = 1,600, which is the most commonly used in similar works. This figure allows us to clearly appreciate the cyclical behavior of the different series analyzed.

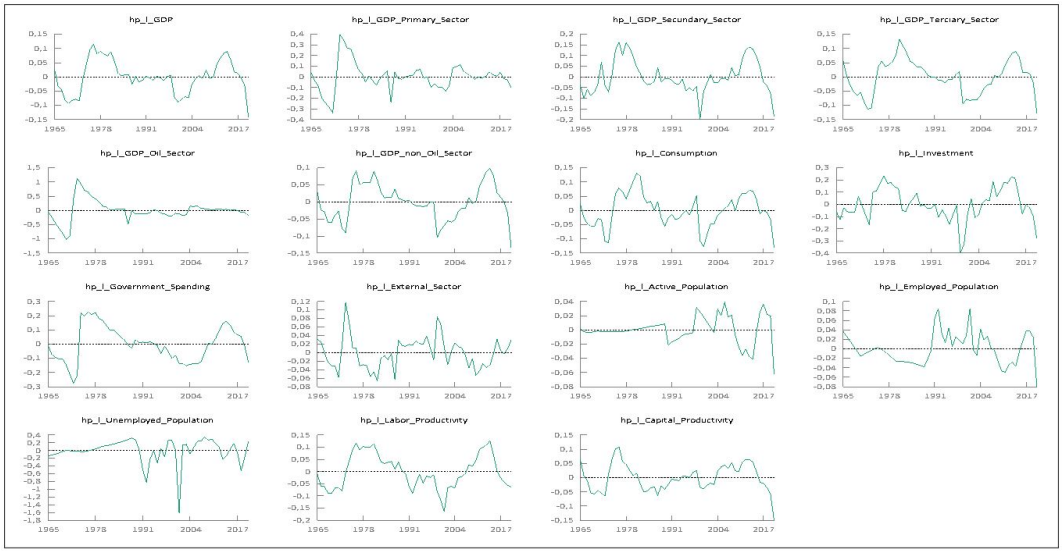

Figure 5: Cyclical Component of the variables using the HP filter

Table 1 shows the description of the cyclical behavior of the Ecuadorian economy, obtained from the HP filter. Using the cyclical component of GDP previously estimated, we can date the cyclical fluctuations of the Ecuadorian economy during the period 1965-2020. During this period, we observe four complete cycles, and another one that is still ongoing. We break down each of these cycles in two ways. First, we speak of cyclical stages in terms of expansion/recession, depending on whether the level of production is above or below trend, respectively. Second, we decompose the cycle into four different phases: slowdown, crisis, recovery and boom, depending on whether the difference of the cyclical component with respect to the trend is positive or negative, both in the recession phase and in the expansion phase.

Table 1: The Ecuadorian business cycle

Period	Cyclical stage	Duration	Period	Cyclical Phase	Duration
1965-1969	Recession	5	1965	Slowdown	1
			1966-1969	Crisis	4
1970-1976	Expansion	7	1970-1973	Recovery	4
			1974-1976	Boom	2
1977-1987	Recession	11	1977-1983	Slowdown	7
			1984-1987	Crisis	4
1988-1998	Expansion	11	1988-1994	Recovery	7
			1995-1998	Boom	4
1999-2000	Recession	2	1999	Slowdown	1
			2000	Crisis	1
2001-2007	Expansion	7	2001-2005	Recovery	5
			2006-2007	Boom	2
2008-2009	Recession	2	2008	Slowdown	1
			2009	Crisis	1
2010-2014	Expansion	5	2010-2011	Recovery	2
			2012-2014	Boom	3
2015-?	Recession	?	2015-2017	Slowdown	3
			2018-?	Crisis	?

The four cycles that we can identify for the Ecuadorian economy cover the periods 1965-1976, 1977-1998, 1999-2007, 2008-2014, added to the last recession period starting in 2015. As we can observe, the recession stages have been much more numerous in terms of duration than the expansion stages, however, the latter have been more pronounced.

3.3.3 Volatility

One of the most important characteristics of this type of analysis is that we can know the magnitude of the fluctuations experienced by the different variables over the cycle. Thus, we will have some variables that show low variability, i.e., that do not experience large cyclical variations, while other variables will experience large variability, with respect to the trend they show in the long term.

Table 2 shows the standard deviation of the cyclical component of each variable according to the decomposition method used. Although the resulting volatility for each variable depends on the filter used, in general we can find a number of well-defined patterns. First, we observe that the volatility of the level of activity of the different productive sectors is very different. Thus, we find high volatility in the cyclical component of the GDP of the primary sector and the oil sector are very high, likewise, investment, government spending and the unemployed population experience high volatility. On the contrary, volatility is lower in the case of the level of activity in the secondary and tertiary sectors, which are the most stable ones.

Table 2: Standard deviation of the cyclical component

	HP	BK	BN	CF	BW
GDP	0.0343	0.0167	0.5602	0.0169	0.0154
GDP Primary	0.1082	0.0691	0.6729	0.0605	0.0491
GDP Secondary	0.0475	0.0340	0.4961	0.0319	0.0287
GDP Tertiary	0.0333	0.0188	0.5864	0.0207	0.0171
GDP Oil Sector	0.2739	0.1712	1.1270	0.1548	0.1106
GDP Non-Oil Sector	0.0315	0.0201	0.5509	0.0209	0.0172
Consumption	0.0382	0.0276	0.5565	0.0289	0.0229
Investment	0.0844	0.0715	0.4812	0.0684	0.0661
Government Spending	0.0749	0.0459	0.5818	0.0437	0.0411
External Sector	0.0297	0.0242	0.0625	0.0226	0.0196
Active Population	0.0162	0.0084	0.4486	0.0091	0.0064
Employed Population	0.0242	0.0162	0.5534	0.0166	0.0146
Unemployed Population	0.2790	0.2480	0.4181	0.2397	0.2341
Labor Productivity	0.0356	0.0215	0.1167	0.0189	0.0159
Capital Productivity	0.0309	0.0161	0.1526	0.0161	0.0143

Table 3 shows the relative variability of each cyclical component with respect to the GDP cycle. A value greater than unity would indicate that the cyclical component of the series in question is more volatile than that corresponding to the aggregate level of output, while a value less than unity would indicate a smoother cyclical profile of the mentioned variable.

Table 3: Relative variability regarding the cyclical component of the GDP

	HP	BK	BN	CF	BW
GDP	1.00	1.00	1.00	1.00	1.00
GDP Primary	3.15	4.14	1.20	3.58	3.19
GDP Secondary	1.38	2.04	0.89	1.89	1.86
GDP Tertiary	0.97	1.13	1.05	1.22	1.11
GDP Oil Sector	7.99	10.2	2.01	9.16	7.18
GDP Non-Oil Sector	0.92	1.20	0.98	1.24	1.12
Consumption	1.11	1.65	0.99	1.71	1.49
Investment	2.46	4.28	0.86	4.05	4.29
Government Spending	2.18	2.75	1.04	2.59	2.67
External Sector	0.87	1.45	0.11	1.34	1.27
Active Population	0.47	0.50	0.80	0.54	0.42
Employed Population	0.71	0.97	0.99	0.98	0.95
Unemployed Population	8.13	14.8	0.75	14.1	15.2
Labor Productivity	1.04	1.29	0.21	1.12	1.03
Capital Productivity	0.90	0.96	0.27	0.95	0.93

In relation to the productive sectors, those with the lowest cyclical volatility in regard to the aggregate level of activity are the tertiary and non-oil sectors, while the primary and secondary have greater volatility. There is also a very high volatility in the oil sector, as a result of the fluctuating prices of this commodity, which are exogenous to the economy. On the other hand, it could be established that the productive sectors with greater cyclical stability are the services sector and the non-oil economy as a whole, which have a lower level of intensity in cyclical fluctuations in relation to the aggregate productivity level of the economy. In this sense, we must take into account that the primary sector, especially the agricultural activity, as well as mining

and oil extraction have a high relative importance in the Ecuadorian economy, being factors of volatility in the aggregate production level of the economy.

Consumption, in general terms, presents greater relative volatility with respect to the level of production, although this is low. The relative variability of consumption is greater than unity, except in the BN filter, indicating deviations from the life cycle theory. This result has important consequences with respect to theoretical developments predicting that consumption should be a variable with smoother dynamics than the level of production. Indeed, the permanent life-cycle-income theory tells us that individuals can select the optimal consumption profile and separate it from their income profile. This would mean that cyclical fluctuations in consumption would have to be smaller than those recorded by the activity of the economy. While this is true in most developed economies, it is not true in the case of the Ecuadorian economy, as it is in the vast majority of developing countries. A plausible explanation is the characteristics of the financial markets, which are underdeveloped (causing the existence of liquidity restrictions, which cause part of the agents not to have access to credit), and the low wages and poor quality of employment, which makes Ecuadorian consumers, for the most part, non-Ricardian, therefore, their level of consumption is highly conditioned by the level of income.

As expected, investment has a very high relative volatility, since it is a highly variable component that is strongly influenced by expectations. This means that the cyclical fluctuations of investment are very high in relation to those of GDP, which is a component of aggregate demand that is sensitive to the economic situation. Public spending also shows a high relative variability much higher than unity. This means that public spending in Ecuador shows a higher variability than GDP. This circumstance is explained by the increases in spending in times of greater economic activity, as a result of the increase in tax revenues and in times of high oil prices, since the state is largely the owner of the oil firms.

On the other hand, the external balance is less volatile than aggregate activity. This means that the volume of exports is not very sensitive to movements in the level of activity. However, empirical evidence indicates that imports do increase in times of higher activity; this condition seems to indicate that, in the face of a variation in the level of income, most of this variation is transformed into imports. With respect to the variables associated with the factors of production, we obtain that the economically active population is more stable than the level of activity, but the opposite occurs with the level of unemployment. Thus, it turns out that unemployment in Ecuador is a more volatile variable than the level of activity. This result also explains why we obtain that labor productivity is more volatile with respect to the level of production.

3.3.4 Comovements

Next, we will calculate the cross-correlations between the different cyclical components and the one corresponding to the level of production. In this way, we can obtain a characterization of the cyclical behavior of the different macroeconomic variables analyzed. The comovements between the different variables selected with GDP are obtained by calculating the correlations between their cyclical components. From these correlations we can characterize the comovements, which allows us to classify the variables as procyclical, countercyclical or acyclical. On the other hand, we calculate the correlations for different moments in time, through the calculation of the cross-correlation function. This allows us to obtain a measure of the synchrony between the different cyclical components.

Productive sectors

First, we will calculate the comovements of the production levels of each of the five productive sectors (primary, secondary, tertiary, oil and non-oil) into which we divide the economy with respect to aggregate production.

Primary Sector: The production level of the primary sector, composed mainly in Ecuador by agriculture, fishing and exploitation of minerals and hydrocarbons contributes 20% of the national GDP, and has a relatively high correlation with respect to the aggregate production level of the economy. Thus, the correlation coefficients are all positive and range from 0.98 with the BN filter to 0.22 with the CF and BW filters. This result indicates that the activity of the primary sector is affected to some extent by the overall level of activity of the economy. This is possibly due to the fact that the volume of investment in this sector is very important in the case of Ecuador, mainly in the oil and mining sector, and that this investment is affected by the general behavior of the economy, which could explain the high correlation between the cyclical fluctuations of the primary sector and general activity. Based on the results obtained, we can conclude that the GDP of the primary sector is procyclical and is coincidental with the aggregate GDP of the economy.

Table 4. Cross Correlations: GDP vs GDP Primary Sector

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.46	-0.25	-0.05	0.17	**0.55**	0.54	0.47	0.23	-0.02
CF	0.04	0.11	-0.19	**-0.36**	0.22	0.22	0.24	-0.01	-0.31
BK	-0.15	-0.10	-0.07	-0.18	**0.33**	0.31	0.30	0.12	-0.21
BN	0.69	0.77	0.85	0.92	**0.98**	0.93	0.87	0.81	0.74
BW	-0.01	0.24	-0.01	**-0.31**	0.22	-0.05	0.06	0.01	-0.04

Secondary Sector: The cyclical component of GDP in the secondary sector responds mainly to manufacturing industries and construction sector which combined contribute with 23% of Ecuadorian GDP. As can be seen, both are closely related to the general level of activity in the economy. The correlation coefficients range from 0.98 in the case of the BN filter to 0.42 for the CF and BK filters. On the other hand, the maximum correlation for all filters is obtained in the period at the same period, being coincidental with the behavior of aggregate activity. Therefore, we can conclude that the GDP of the secondary sector is a procyclical variable and coincidental with the aggregate activity level of the economy.

Table 5. Cross Correlations: GDP vs GDP Secondary Sector

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.07	-0.01	0.13	0.28	**0.58**	0.33	0.23	0.19	0.10
CF	0.06	-0.10	-0.12	0.03	**0.42**	-0.20	-0.32	-0.04	0.25
BK	0.04	-0.07	-0.10	0.11	**0.42**	0.01	-0.15	0.01	0.23
BN	0.74	0.80	0.87	0.93	**0.98**	0.93	0.86	0.80	0.73
BW	0.10	-0.07	-0.14	-0.07	**0.55**	-0.15	-0.20	0.05	0.14

Tertiary Sector: The service sector is the sector with the greatest weight in the economy GDP with 55%, so we should expect its behavior throughout the cycle to be similar to that of the economy as a whole. Indeed, these are the results we obtain. The results yielded by the different filters are very similar, presenting a high correlation with the cyclical component of the aggregate GDP of the economy, with values ranging from 0.76 to 1.00. Therefore, service sector GDP is procyclical and coincidental with the aggregate activity of the economy.

Table 6. Cross Correlations: GDP vs GDP Tertiary Sector

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	0.10	0.22	0.37	0.57	**0.82**	0.33	-0.05	-0.22	-0.28
CF	-0.24	-0.39	-0.27	0.22	**0.81**	0.05	-0.52	-0.36	0.06
BK	-0.13	-0.11	-0.05	0.33	**0.76**	0.14	-0.39	-0.23	-0.02
BN	0.76	0.82	0.88	0.94	**1.00**	0.94	0.87	0.80	0.74
BW	0.09	-0.04	-0.26	-0.07	**0.85**	-0.06	-0.37	-0.03	0.24

Oil Sector: The oil sector is especially relevant in the case of the Ecuadorian economy, representing approximately 11% of GDP during the entire period analyzed. The results in this case show quite different values depending on the filter applied, ranging from -0.06 in the CF filter to 0.88 in the BN filter. For the purposes of this paper, we will consider the results obtained by the HP filter as valid, therefore, the GDP of the oil sector is procyclical and is two periods lagged of the aggregate activity of the economy.

Table 7. Cross Correlations: GDP vs GDP Oil Sector

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.41	-0.25	-0.08	0.11	0.44	0.53	**0.54**	0.32	0.23
CF	0.16	0.16	-0.12	**-0.43**	-0.06	0.22	0.40	0.16	-0.27
BK	-0.10	0.09	-0.01	-0.23	0.11	0.32	**0.43**	0.23	-0.15
BN	0.47	0.58	0.69	0.79	**0.88**	0.85	0.81	0.76	0.70
BW	-0.01	0.22	0.11	**-0.30**	-0.04	-0.03	0.14	0.07	-0.10

Non-Oil Sector: The non-oil sector includes the economic activity outside the exploration, exploitation and export of oil in Ecuador, accounting for about 84% of GDP. The results in this case show similar values depending on the filter applied, ranging from 0.70 in the BK filter to 1.00 in the BN filter, indicating that by detaching the economy from the oil sector, it gains stability. The GDP of the non-oil sector is procyclical and is coincidental with the aggregate activity of the economy.

Table 8. Cross Correlations: GDP vs GDP non-Oil Sector

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.04	0.08	0.29	0.54	**0.84**	0.39	0.07	-0.07	-0.13
CF	-0.19	-0.34	-0.23	0.23	**0.73**	-0.06	-0.52	-0.28	0.15
BK	-0.13	-0.16	-0.09	0.34	**0.70**	0.08	-0.35	-0.15	0.09
BN	0.76	0.83	0.89	0.95	**1.00**	0.94	0.87	0.80	0.73
BW	0.08	-0.08	-0.24	-0.02	**0.78**	-0.12	-0.35	0.01	0.23

Aggregate demand components

Next, we will describe the cyclical behavior of the components of aggregate demand, namely consumption, investment, public spending and the external sector balance.

Consumption: Consumption is the main component of the GDP for most countries. According to the data used, consumption accounts for around 63% of the Ecuadorian GDP. This quantitative importance makes its cyclical characterization very important. All filters indicate that consumption is a procyclical variable, having the highest correlation at the present period. The results range from a correlation of 0.67 in the BK filter to 1.00 in the BN filter. The results obtained for the Ecuadorian economy are similar to those of other developing economies, with consumption being a highly procyclical and synchronized variable with respect to fluctuations in the economy output.

Table 9. Cross Correlations: GDP vs Consumption

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	0.08	0.12	0.24	0.49	**0.73**	0.29	-0.05	-0.15	-0.16
CF	-0.16	-0.40	-0.32	0.24	**0.74**	0.05	-0.49	-0.30	0.11
BK	-0.06	-0.21	-0.19	0.29	**0.67**	0.08	-0.40	-0.15	0.10
BN	0.75	0.81	0.88	0.94	**1.00**	0.94	0.88	0.81	0.75
BW	0.12	-0.09	-0.28	0.03	**0.73**	-0.08	-0.38	0.01	0.30

Investment: Investment is a very important component for the aggregate demand of an economy, not only in quantitative terms like consumption, but in qualitative terms. Investment determines the process of capital accumulation and, therefore, determines its future growth possibilities. In the Ecuadorian economy, according to the data used, it represents around 25% of GDP during the period analyzed. Investment is a highly volatile component, presenting a high variability over time since it is fundamentally tied to the population expectations. The corresponding cross-correlation presents similar results for all filters used, given these particular dynamics of investment, the results range from 0.45 with the HP filter to 0.93 with the BN filter. Investment, then, would be a procyclical variable with the general level of activity of the economy and with synchronized cyclical phases.

Table 10. Cross Correlations: GDP vs Investment

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	0.08	0.05	0.08	0.19	**0.45**	0.14	0.02	0.14	0.16
CF	0.14	-0.14	-0.24	0.02	**0.50**	-0.15	-0.39	0.04	0.29
BK	0.14	-0.09	-0.20	0.07	**0.46**	-0.10	-0.29	0.17	0.21
BN	0.71	0.76	0.82	0.87	**0.93**	0.87	0.81	0.74	0.67
BW	0.20	-0.04	-0.21	-0.07	**0.64**	-0.12	-0.35	0.11	0.26

Government Spending: Government spending is a component of aggregate demand that is determined by the country public policies. In the period analyzed, it has represented an average value of around 14% of GDP, although its weight has varied gradually over time depending on the political vision of the government in power. The analysis of the cyclical behavior of public spending is of great importance, since it will indicate both the type of fiscal policy carried out according to the cyclical behavior of the economy and the importance of the shocks derived from this policy. If fiscal policy is used as a stabilization policy, it is expected to be countercyclical. That is, public spending would tend to decrease in expansionary phases, while it would increase in recessionary phases. However, if fiscal policy acts as an automatic mechanism, we should expect the opposite behavior, i.e., increases in public spending in expansion phases and decreases in public spending in recession phases, in line with the behavior of public revenues derived from taxes.

The correlation matrix for the cyclical component of public spending shows that in all cases we obtain that public spending is a procyclical variable, with very high correlation coefficients in most cases. In general terms, the results seem to indicate that public spending in Ecuador is a procyclical variable and synchronized with the level of economic activity. This would indicate that fiscal policy on the expenditure side is not stabilizing the economy, but is merely an automatic mechanism, whereby public spending increases when public revenues are higher and decreases when public revenues fall.

Table 11. Cross Correlations: GDP vs Government Spending

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	0.03	0.21	0.36	0.59	**0.72**	0.47	0.16	-0.11	-0.18
CF	-0.01	-0.20	-0.29	0.19	**0.44**	0.17	-0.24	-0.45	-0.07
BK	0.08	0.03	-0.09	0.30	**0.41**	0.24	-0.09	-0.33	-0.06
BN	0.68	0.76	0.83	0.90	**0.97**	0.90	0.83	0.76	0.68
BW	0.18	-0.02	-0.30	0.04	**0.42**	0.07	-0.09	-0.22	0.13

External Sector: The last component of aggregate demand is the external sector, measured through net exports, that is, exports minus imports. This external balance has historically been negative and has experienced an increasing trend for the Ecuadorian economy, although compensated by oil exports, indicating that the rate of increase of imports has been higher than that of non-oil exports. We find different results depending on the filter used. If we consider the CF, BK and BW filters, the correlation is negative, although for the purposes of this paper we will take as a reference the HP filter, which indicates that the external balance is procyclical. This means that the higher the level of production, the higher the level of imports that increase the non-oil trade deficit. Thus, the trade deficit increases in expansionary periods and decreases in recessionary periods. Regarding synchrony, the results show a great disparity. According to the HP filter, the external balance would be ahead for two periods, according to the BN and BW filters it would be coincidental and according to the BK and BN filters it would be ahead for two periods. Based on these results we can affirm that the external balance is a procyclical variable and that it is two periods ahead of the aggregate production level.

Table 12. Cross Correlations: GDP vs External Sector

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.36	-0.20	-0.10	-0.07	0.04	0.22	**0.32**	0.12	-0.11
CF	-0.03	0.24	0.14	-0.26	-0.28	0.09	0.42	0.08	**-0.37**
BK	-0.14	0.16	0.13	-0.20	-0.16	0.16	0.39	0.02	**-0.29**
BN	0.38	0.43	0.49	0.52	**0.55**	0.53	0.51	0.49	0.47
BW	-0.16	0.16	0.19	-0.14	**-0.35**	0.01	0.33	0.01	-0.33

Factors Market

The third and last block of variables analyzed corresponds to factor markets, basically the labor market. In this case we will analyze the cyclical behavior of the labor force, employment, unemployment and labor productivity. In addition, we introduce a variable whose analysis may also be of interest, namely capital productivity. In the following, we analyze the comovements of this set of variables.

Economically Active Population: In theory, the economically active population should be a procyclical variable. A higher level of activity in the economy leads to improvements in access to employment, which would encourage more of the working-age population to enter the labor market. These theoretical assumptions are corroborated by the results obtained. The highest values correspond to the BN filter, with a correlation coefficient of 0.99, while the Hp, CF, BK and BW filters show lower coefficients. On the other hand, the HP filter indicates that these variable lags 4 periods in regard to the level of activity, in what seems to indicate that the population that joins the labor market is guided by expectations of improvement in the economy. Therefore, we can conclude that the labor force is a slightly procyclical variable and lagged 4 periods with respect to the cycle of the level of production.

Table 13. Cross Correlations: GDP vs Active Population

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	**0.16**	0.15	0.11	0.04	0.11	-0.29	-0.30	-0.34	-0.25
CF	0.21	-0.08	-0.22	-0.15	**0.34**	-0.13	0.13	-0.02	-0.13
BK	0.18	**0.20**	0.11	0.05	0.06	-0.28	-0.09	-0.11	-0.08
BN	0.78	0.83	0.89	0.94	**0.99**	0.93	0.86	0.80	0.73
BW	0.23	-0.04	-0.13	-0.02	**0.47**	-0.35	0.25	0.01	-0.15

Employed population: Employment is another example of a procyclical variable, increasing in expansion stages and decreasing in recession stages, in line with the level of economic activity, which is precisely the result we obtain for the Ecuadorian economy. All filters show positive results, these positive correlations indicating that employment is a procyclical variable and point to employment being synchronized with fluctuations in economic activity. This result will also have implications in terms of labor productivity, since the cyclical evolution of labor productivity depends on the relative variability of the cyclical component of employment in relation to that of production. As we have seen above, the variability of employment in the economy is lower than the variability of the level of production, which means that employment is not destroyed until there is a recession or employment is not created until there is a recovery. In other words, in the Ecuadorian economy, employment begins to be created or destroyed at the same time as the evolution of production.

Table 14. Cross Correlations: GDP vs Employed Population

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	0.02	0.12	0.05	0.09	**0.30**	0.01	-0.09	-0.10	-0.08
CF	0.13	0.11	-0.24	-0.16	**0.36**	0.05	-0.12	-0.11	-0.12
BK	0.05	0.28	-0.09	-0.10	**0.15**	0.03	-0.10	-0.01	-0.06
BN	0.78	0.84	0.89	0.94	**0.98**	0.92	0.86	0.79	0.73
BW	0.08	0.18	-0.18	-0.13	**0.44**	-0.03	-0.07	0.04	-0.05

Unemployed population: In most economies, unemployment is a countercyclical variable, decreasing in expansionary phases and increasing in recessionary phases. Given the results obtained above for economically active population and employment, it is to be expected that also for the Ecuadorian economy unemployment is a countercyclical variable. The cross-correlations show how all the filters give rise to negative correlation coefficients between the cyclical component of unemployment and that corresponding to aggregate production. Regarding synchrony, only the BK and BN filters seem to indicate that unemployment is a lagged variable, while the other CF and BW filters suggest that it is synchronized with the level of activity. Taking the results of the Hp filter as a reference, the unemployed population is a countercyclical and ahead variable.

Table 15. Cross Correlations: GDP vs Unemployed Population

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.06	-0.10	0.11	0.07	-0.10	-0.07	0.06	-0.10	**-0.11**
CF	-0.06	-0.22	0.22	0.11	**-0.22**	-0.15	0.28	0.06	-0.04
BK	-0.01	**-0.25**	0.22	0.18	-0.10	-0.14	0.14	-0.06	-0.03
BN	-0.51	**-0.52**	-0.50	-0.49	-0.48	-0.45	-0.40	-0.33	-0.29
BW	-0.03	-0.24	0.23	0.13	**-0.37**	-0.18	0.29	-0.04	-0.06

Labor productivity: In most economies, labor productivity is a procyclical variable. This is because, although employment is a procyclical variable, as we have seen

above, it has less variability than the aggregate level of production of the economy, so that in expansion phases employment increases less than the level of production, resulting in an increase in labor productivity. Using all the filters we obtain that the correlation is positive, that is, we obtain that labor productivity in Ecuador is a procyclical variable, increasing in expansion stages and decreasing in recession stages. In addition, we note that labor productivity is coincidental with the level of production. These results indicate that, in expansionary phases, employment increases, but it does so in a smaller proportion than the level of production, evidencing the existence of technological factors that increase labor productivity, while the opposite occurs in recessionary phases. This is due to the fact that the variability of employment is lower than the variability of production. On the contrary, in recessionary phases, the destruction of employment is lower than the decrease in activity levels, resulting in a decrease in labor productivity.

Table 16. Cross Correlations: GDP vs Labor Productivity

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.18	-0.05	0.23	0.49	**0.76**	0.55	0.33	0.09	-0.11
CF	-0.20	-0.38	-0.15	0.17	**0.57**	-0.02	-0.26	-0.19	0.03
BK	-0.13	-0.27	-0.05	0.26	**0.67**	0.17	-0.04	-0.05	-0.05
BN	-0.15	-0.07	0.01	0.09	**0.16**	**0.16**	0.15	0.13	0.10
BW	0.08	-0.14	-0.11	-0.07	**0.57**	-0.16	-0.22	-0.01	0.20

Capital productivity: Finally, we analyze the cyclical behavior of capital productivity, calculated as the production-stock ratio of physical capital in the economy. Similar to what happens with labor productivity, in this case we find that capital productivity is a procyclical variable. Indeed, all filters show a high correlation between the cyclical movements of capital productivity and aggregate output of the economy. With respect to synchronization, we can see that capital productivity is coincidental with the level of output. The fact that capital productivity is procyclical is evidence that in expansion phases the increase in the capital stock is lower than the increase in the level of production, which is consistent with most theoretical models. There is also evidence of a very close behavior in the short and medium term between production and the process of capital accumulation, a relationship that is made possible by the high volatility of investment.

Table 17. Cross Correlations: GDP vs Capital Productivity

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
HP	-0.32	-0.13	0.14	0.48	**0.95**	0.60	0.34	0.12	-0.06
CF	-0.09	-0.29	-0.41	0.01	**0.98**	0.09	-0.39	-0.37	-0.12
BK	-0.15	-0.10	-0.23	0.14	**0.96**	0.29	-0.13	-0.09	-0.09
BN	0.69	0.76	0.82	0.88	**0.93**	0.91	0.87	0.83	0.77
BW	0.15	0.05	-0.30	-0.23	**0.98**	-0.14	-0.28	-0.02	0.15

3.3.5 Characterization of the variables

Once the above analyses have been carried out, we then proceed to the cyclical classification of the variables in terms of three characteristics: comovement, synchrony and volatility. The synthesis of the results obtained is shown in Table 18.

Table 18. Variable Classification

	Comovement	Synchronization	Volatility
GDP Primary	Procyclic	Coincidental	Very high
GDP Secundary	Procyclic	Coincidental	High
GDP Tertiary	Procyclic	Coincidental	Low
GDP Oil Sector	Procyclic	Follows	Very high
GDP Non-Oil Sector	Procyclic	Coincidental	Low
Consumption	Procyclic	Coincidental	High
Investment	Procyclic	Coincidental	Very high
Government Spending	Procyclic	Coincidental	Very high
External Sector	Procyclic	Follows	Low
Active Population	Procyclic	Anticipates	Very high
Employed Population	Procyclic	Coincidental	Low
Unemployed Population	Countercyclic	Follows	Very high
Labor Productivity	Procyclic	Coincidental	High
Capital Productivity	Procyclic	Coincidental	Low

As we can see, all variables are procyclical, except for unemployment, which has a countercyclical behavior. In the case of unemployment this behavior is as expected and corroborates the evidence observed in most countries, in which labor productivity is procyclical or in some cases acyclical. Regarding synchrony, we obtain that most of the variables are coincidental with the level of activity of the economy, except for oil GDP, the external sector, the unemployed population and the economically active population, the first three seem to reflect an ahead behavior, and the last a lagged one.

Finally, with respect to the relative volatility of the different variables with respect to the aggregate GDP, we obtain that the primary sector, the oil sector, investment, government spending and the unemployed population, show a very volatile behavior, with a great variability in the short and medium term, evidencing the existence of very pronounced cyclical fluctuations for these variables. The secondary sector, consumption and labor productivity also show greater variability than aggregate activity. In the case of consumption, this result indicates the existence of deviations from the life-cycle hypothesis, reflecting the existence of rigidities in the credit and labor markets that cause consumption to vary significantly in response to changes in income. The high volatility of public spending is also notable. In this case, it seems that the elasticity of public revenue with respect to output is greater than unity, which also results in higher public spending in when there is an increase in the level of activity. Finally, the low volatility of employment causes labor productivity to be procyclical, since it increases in expansionary phases and decreases in recessionary phases. Similarly, the service sector, non-oil, the external sector, the labor force and capital productivity show lower levels of volatility than the aggregate level of production.

3.4 Concluding remarks

In this paper we have characterized the so-called stylized facts of the Ecuadorian business cycle. For this purpose, we have selected a set of variables representative of the Ecuadorian economy. Although it is advisable to analyze the business cycle in the short and medium term, due to various limitations we have resorted to annual series from 1965 to 2020. In order to carry out the analysis, first of all, we have to decompose the time series into its trend component and its cyclical component. This

component can be obtained by applying a filter to the series that allows us to separate the secular trend part in order to isolate the cyclical fluctuations. In this work we have applied a wide range of filtering methods, since the results derived from their application can be very different. Starting from the cyclical component, we have performed several analyses with the objective of determining the main characteristics of cyclical fluctuations in Ecuador. Specifically, we have analyzed the volatility of the different variables, as well as their comovements.

The main results obtained when analyzing the productive sectors show, as expected, a very high volatility of the primary and oil sectors, as a consequence of the productive structure of the economy and the high dependence of the country on changes in the prices of its main export commodities, agricultural products and oil. This is due to the fact that the volume of investment in this sector is very important in the case of Ecuador, mainly in the oil and mining sector. These are procyclical in relation to aggregate production and show a coincidental and forward synchronization respectively. On the other hand, the tertiary sector is the one that shows greater stability in the long term, experiencing a low level of volatility and occupying a preponderant role in the Ecuadorian economic structure, especially in the 21st century.

Regarding the components of aggregate demand, we find results that clearly correspond to the characteristics of the Ecuadorian economy, among them consumption, which shows high volatility, while being procyclical and coincidental with respect to the level of production, contradicting the life cycle theory. This is due to the characteristics of the Ecuadorian financial markets, which are not very developed, and to the low salaries and poor quality of employment, which makes Ecuadorian consumers mostly non-Ricardian, and therefore, their consumption level is highly conditioned by their income level.

Public spending shows a very high relative variability, as well as a procyclical and coincidental compartment with economic activity. This means that public spending in Ecuador varies between periods of higher and lower economic activity, as a result of the increase in tax revenues and periods of oil bonanza, since the state is largely the owner of oil revenues. This is a clear indication that fiscal policy is not stabilizing the economy, but rather is an automatic mechanism whereby public spending increases when public revenues are higher and decreases when public revenues decrease. For its part, the external balance is less volatile than aggregate activity, as well as procyclical and ahead of GDP. This means that the volume of exports is not very sensitive to movements in the level of activity. However, empirical evidence indicates that imports do increase in times of higher activity, this condition seems to indicate that, in the face of a variation in the level of income, most of this variation is transformed into imports. This external balance has historically been negative and has experienced an increasing trend for the Ecuadorian economy, although compensated by oil exports, indicating that the rate of increase of imports has been higher than that of non-oil exports.

With respect to the variables associated with productive factors, we find that the labor force is more stable than the level of activity, and is also procyclical and lagged. This seems to indicate that the population entering the labor market is guided by expectations of improvement in the economy. On the employment side, employment shows a lower variability in the economy than the level of production, which means that employment is not destroyed until there is a recession or employment is not created until there is a recovery. In other words, in the Ecuadorian economy, employment begins to be created or destroyed at the same time as the evolution of production. This is confirmed by the fact that it has a procyclical movement and

a synchronization coincidental with GDP. Finally, in accordance with the theoretical postulates, unemployment in Ecuador is a variable with a very high volatility, countercyclical and ahead of the level of production. This result explains why we obtain that labor productivity presents a higher volatility with respect to the level of production.

Regarding labor productivity, the results indicate that it has a very high volatility, procyclical and coincidental with GDP, which tells us that, in expansionary phases, employment increases, but does so at a lower rate than the level of production, evidencing the existence of technological factors that increase labor productivity, while the opposite occurs in recessionary phases. This is due to the fact that the variability of employment is lower than the variability of production. Thus, in expansion phases, employment increases less than the level of production, resulting in an increase in labor productivity, evidencing the existence of positive technological factors. On the contrary, in recessionary phases, the destruction of employment is less than the decrease in activity levels, resulting in a decrease in labor productivity. Finally, the fact that capital productivity is procyclical is evidence that in expansion phases the increase in the capital stock is lower than the increase in the level of production, which is consistent with most theoretical models. There is also evidence of a very close behavior in the short and medium term between production and the process of capital accumulation, a relationship that is made possible by the high volatility of investment.

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Chapter 4

The Ecuadorian business cycle in the international context

This research studies the synchronization of the Ecuadorian business cycle with the countries of the Andean Community of Nations in two stages (1950-1994, 1995-2019) and focuses on whether the business cycles with its neighbors have become more similar over time, especially in the period prior to and following the signing of the Cartagena Agreement and the birth of the Andean Community of Nations. We also study the level of synchronization with its main international trading partners. We conclude that the business cycles of the member countries have gone through periods of both convergence and divergence. However, there is considerable evidence that, since the 1994 integration, business cycle synchronization in the CAN area has increased. It is found that such trade intensity led to greater synchronization, however, these results suggest but do not confirm the existence of a common business cycle, not ruling out, therefore, the possibility of a monetary union. On the other hand, it confirms the country's dependence on periods of economic expansion of its trading partners to stimulate its level of economic activity.

4.1 Introduction

It is well known that macroeconomic volatility generates both economic and political uncertainty, with detrimental effects on investment and consumption plans and, ultimately, on future economic growth and aggregate welfare. The analysis of volatility evolved in work on business cycles with the seminal work of Mitchell (1913), Kuznets (1926) and Mills (1936) first, but it was with Lucas (1972) that the characterization of fluctuations as well as the explanation of their causes was taken up with special interest.

The description of the business cycle involves the measurement of the volatility of the main macroeconomic variables, that is, the movements of these variables around their respective trend, the persistence of the cyclical component of these variables, as well as the co-movements of the cyclical component of all variables with that of real output. Therefore, there is great interest among both academics and policy makers to shed light on the sources of output fluctuations, especially in the new globalized economic environment, characterized by a much larger role of emerging market countries and low growth and uncertainty in advanced economies. However, it has been during the last two decades that the study and systematic measurement of economic fluctuations has seen greater development, which has provoked considerable macroeconomic debate. Some of this research has been assembled into a body of theory known as the Real Business Cycle (RBC) approach.

Whereas economic linkages between countries around the world have increased rapidly in recent years thanks to trade and financial integration. With regard to trade, the cumulative increase in the volume of world trade is almost three times greater than that of world output between 1960 and 2010. The rate of increase is even faster in emerging and developing economies, where it has risen from 6% in 1980 to 9% in 2010. On the financial side, the world's total foreign assets increased from 19% of world GDP in 1980 to 172.4% in 2011, and total portfolio investment in the world increased from 19% of world GDP in 1997 to 55.5% in 2011. These figures show that there is strong momentum behind the growth of trade and financial globalization. This growth has been reflected to regional economic linkages. Multiple trade agreements and trade unions, e.g., CAN, ASEAN, NAFTA, MERCOSUR and the EU, have been formed on a regional basis.

Knowledge of contagion effects between countries is especially relevant for emerging countries due to their higher degree of volatility compared to more mature economies. Both internal and external factors explain why emerging economies are so volatile: (1) intrinsic instability induced by the development process itself; (2) lack of effective mechanisms (such as well-functioning financial markets and adequate macroeconomic stabilization policies) to absorb external fluctuations; and (3) exposure to exogenous shocks in the form of sudden capital inflows/outflows and/or large changes in international terms of trade.

Separating the effects of regional and global integration is important. An economic event in the major industrial countries substantially affects emerging and developing countries through the economic linkages between the two groups of countries. Therefore, economic integration with industrial countries is likely to be important in explaining the business cycles of emerging and developing countries, as well as the co-movements of business cycles of countries in a region. Economic theory does not offer unambiguous predictions: International financial and trade linkages could lead to a greater or lesser degree of business cycle co-movement, meaning that the underlying economic relationships of countries significantly affect their business cycle co-movement through trade and financial integration. In particular, various types of regional and global integration influence the co-movement of the business cycle among countries within a region.

For example, a recession in the United States can worsen the trade balance of two developing countries in a region and generate business cycle co-movements between those two countries. This effect of global economic integration on business cycle co-movements can be as important as the effects of global economic integration on business cycle co-movements. This effect of global economic integration on the co-movements of the business cycle can be as important as the effects of regional economic integration. Since the effects of these two types of economic integration may be different, separating them is crucial to measure the precise effect of each type of integration. Moreover, discovering the relative importance of regional versus global economic integration in explaining the business cycle co-movements of countries in a region is an important issue in itself. The question of the business cycle synchronization of countries in a region has several important implications for that region. When the degree of business cycle synchronization in a region is high, emphasis can be placed on common policy responses and/or policy cooperation within the region to stabilize it.

Within the business cycle literature, two views have been presented on this issue. In what we call the "optimistic view", greater economic (and monetary) integration will lead to less divergence. This view is quite popular among policy makers in the European Union, for example. However, other economists argue that if there is

a similar concentration of industries in particular regions, because of economies of scale and scope, sector-specific shocks may become regional shocks, thus increasing the likelihood of asymmetric shocks and divergent business cycles. Therefore, the "pessimistic view" argues that business cycles in the euro area may become more divergent in the future.

In the debate on the synchronization of business cycles in Latin America, two questions can be asked. First, have business cycles in the region become more similar and, second, what events have driven business cycle synchronization? On the first issue, the literature has not yet reached a consensus on whether the business cycles of the region's countries are converging. Differences among various studies can be partly explained by the use of different data. However, other reasons include the use of divergent methods for identifying business cycles and assessing convergence. Competing methods have been suggested for calculating a business cycle. There is also no consensus on how convergence between business cycles should be measured. Regarding the second issue, several factors that can affect business cycle synchronization have been raised, ranging from trade relations (Frankel and Rose, 1998), specialization (Imbs, 2004), monetary integration (Fatas, 1997), financial relations. (Imbs, 2006) and shared borders (Clark and van Wincoop, 2001). However, despite the theoretical and empirical analyses to date, it seems fair to say that there is no consensus on the important determinants of business cycle co-movement, the main difficulty being the existence of multiple possible explanations.

This paper analyzes the effects of economic integration on the co-movements of Ecuador's business cycle with the countries of the Andean Community of Nations, as well as with its four main partners: United States, European Union, China and Russia.

The rest of the article is organized as follows. Section 2 reviews the data used, as well as the method for identifying business cycles and business cycle synchronization. Section 3 discusses the results obtained and the last section provides the relevant conclusions as well as some concluding remarks.

4.2 Methodology

Studies examining the synchronization of business cycles in the Latin American region tend to reach very different conclusions. Part of these differences may be related to the selection of variables used, divergent methodologies for constructing business cycles and alternative ways of assessing synchronization. The methodology used in this paper is described below.

4.2.1 Data used

The variable used was the annual data on real GDP in 2017 values of Ecuador, Colombia, Peru and Bolivia, being the broadest production variable. The time series was divided into two periods, 1950-1994 and 1995-2019, this because 1994 is a relevant point in the history of the Andean Community of Nations, this being the year of entry into force of the Common External Tariff. In the case of the cycles of the main trading partners, a 1995-2020 series was used. Generally, annual data would be avoided in order to capture more high frequency fluctuations, however, unfortunately in the Latin American case the absence of long duration databases at shorter frequencies does not exist in the long run. GDP has been chosen instead of the Index of Industrial Production because manufacturing activity is less representative

in Latin America compared to Europe or the United States, so a priori it would not seem to be representative of total production. Second, manufacturing production is much more volatile than aggregate production. The data were taken from Penn World Table v.10 and supplemented with information from the Central Banks of the respective countries.

4.2.2 Business Cycle Measurement

In order to carry out studies of this type, a first distinction to be made is between classic business cycles and deviation (or growth) cycles, i.e. the difference between the cyclical and trend component of a time series. (Classical) business cycles are defined in terms of absolute expansions and contractions of economic activity. Similar studies use a variety of filtering techniques to decompose the output into trend and cycle. Among them the simplest filtering technique is to calculate the first differences, the Baxter-King (1999) band-pass filter and the phase average trend using the Bry-Boschan (1971) algorithm. For this study we used the Hodrick-Prescott (1997) non-parametric filter, which is probably the most widely used filter in this type of research. This filter estimates the trend component by minimizing deviations from the trend, subject to a predetermined smoothness of the resulting trend.

4.2.3 Synchronization measurement

Given a certain measure of the business cycle, one has to determine to what extent these cycles move together across countries. Several techniques have been suggested for this type of study, such as Harding and Pagan's (2002) matching index and Bernard and Durlauf's stochastic definitions of convergence. For this study, however, a cross-correlation analysis was performed.

4.3 Results and discussion

For this section we have divided the results among the two main group of countries the Ecuador maintain intense trade ties. First, we will analyse the countries from the South American Andean Community of States. Second, the trade ties between Ecuador and its main international partners.

4.3.1 Business cycle synchronization in the Andean Community of States

The CAN countries share similar productive structures and generally compete for the same markets and are affected by fluctuations in developed countries. Although the volume of trade between the countries is considerably less than that with the developed economies and therefore less conditioned by the surrounding economies, it is of interest to study the cyclical behavior of the Ecuadorian economy in relation to the cyclical behavior of those countries. To determine the extent to which the cyclical fluctuations of the CAN countries affect their performance, we will compare the cyclical performance of the Ecuadorian economy with the cyclical performance of the main economies of this regional agreement. These countries are Colombia, Peru and Bolivia.

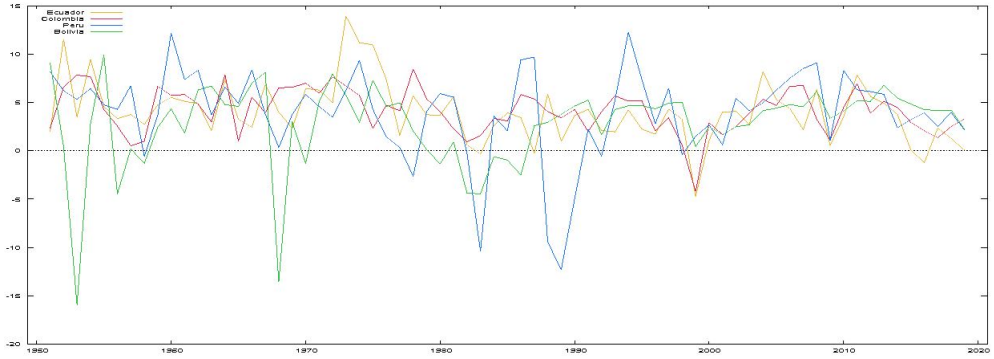

Figure 1: Interannual growth rate for the CAN countries

Figure 1 shows the year-on-year GDP growth rate in Ecuador and the countries of the region. As we can see, the behavior of growth is quite different, with fluctuations in Peru, Bolivia and, to a lesser extent, Ecuador, with Colombia being the most stable. There is also a closer correlation between Ecuador and Colombia than among the others. This means that the Ecuadorian economy has been historically linked to the Colombian economy, both because of the existing commercial proximity and because of the similarity of their productive structures, affected in a similar way by the fluctuations of commodities in the international markets, mainly oil, coffee and bananas. It is worth mentioning the rapprochement that has existed since 1995, since the entry into operation of the single regional tariff, which has allowed economic cycles to be synchronized, especially with respect to recessions.

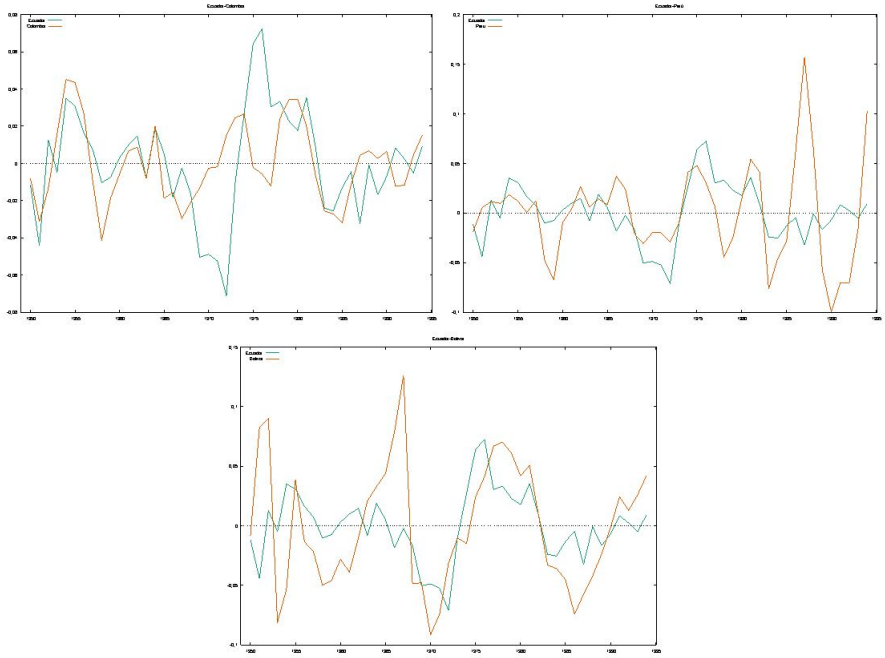

Figure 2: Comparison of the Ecuadorian cyclical component with its CAN trade partners (1950-1994)

Figure 2 shows how the economic cycle has a distant relationship among the countries analyzed. We found important differences with respect to Ecuador's cyclical behavior with the rest of the economies, with the cycles of Ecuador and Colombia being the most similar to the national cycle.

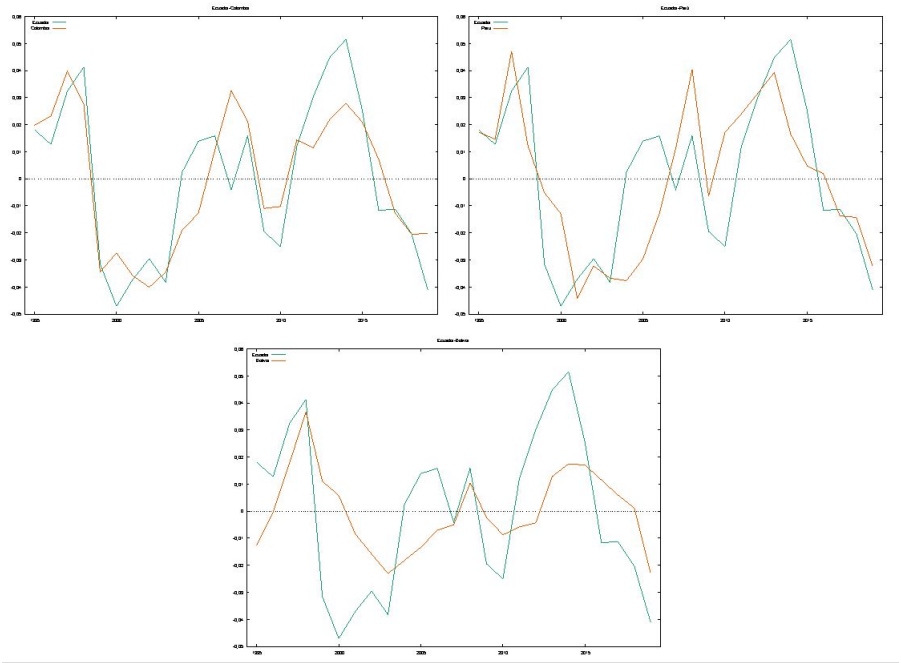

Figure 3: Comparison of the Ecuadorian cyclical component with its CAN trade partners (1995-2019)

In Figure 3 we can notice two things: the level of synchronization of the cycles has experienced a rapprochement with respect to previous levels, especially the cycles of Ecuador with Colombia and Peru are quite close, and secondly, volatility has decreased.

Table 1 shows the volatility of the cyclical components for the two periods. As we can see, the variability of the Ecuadorian cycle in the first period analyzed is surpassed by Peru and Bolivia, and is only comparable to that of Colombia, which is the closest country in volatility of those analyzed.

In the second period, however, we note that the levels of volatility among the countries have become much closer, especially Bolivia and Peru reached levels of stability comparable to Colombia and Ecuador, which has the most volatile cycle in this period.

Table 1: Volatility of the Cyclical Component

	1950-1994		1995-2019	
	Std. Dev.	Relative Dev.	Std. Dev.	Relative Dev.
Ecuador	0.029	1.000	0.029	1.000
Colombia	0.021	0.728	0.025	0.846
Peru	0.048	1.674	0.026	0.903
Bolivia	0.052	1.798	0.015	0.498

Table 2 shows the cross-correlation matrix between the different cyclical components extracted through the use of the HP filter in the period 1950-1994. As we can see, the correlation with the cyclical component between Ecuador and the other economies is not very high, indicating that the national cycles move in a not very similar way in this period.

It is worth noting that only Peru has a pro-cyclical behavior that coincides with that of Ecuador, although its correlation coefficient is quite low. On the other hand, with respect to Colombia's economic cycle, it is shown that the Ecuadorian cycle is

one period ahead with a coefficient of 0.441. Finally, in the case of Bolivia, a pro-cyclical behavior is observed with the highest coefficient of those reviewed, and a delay of two periods.

Table 2. Correlations of the GDP cyclical component (1950-1994)

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
Colombia	-0.132	-0.138	-0.013	0.117	0.379	**0.441**	0.389	0.256	0.133
Peru	-0.240	-0.182	-0.044	0.129	**0.249**	0.184	0.012	-0.060	-0.029
Bolivia	0.021	0.338	**0.453**	0.369	0.427	0.349	0.143	-0.022	-0.222

Table 3 shows the cross-correlation matrix between the different cyclical components extracted through the use of the HP filter in the period 1995-2019. We can notice how the cycles have synchronized to a large extent, especially those of Colombia and Peru with Ecuador, reaching pro-cyclical coincident behaviors and correlation coefficients of 0.842 and 0.677 respectively. In the case of Peru, a two-period lag is still observed, although its coefficient is higher than in the previous scenario.

Table 3. Correlations of the GDP cyclical component (1995-2019)

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
Colombia	-0.334	0.076	0.393	0.602	**0.842**	0.586	0.105	-0.223	-0.316
Peru	-0.085	0.127	0.435	0.513	**0.677**	0.516	0.177	-0.053	-0.141
Bolivia	0.122	0.509	**0.673**	0.657	0.529	-0.104	-0.504	-0.551	-0.337

Several studies examining the correlation of cyclical indicators over time in Latin American countries and their different regional integration process reach quite similar conclusions, including Ávila-Vélez, J., & Pinzón-Giraldo, Á. J. (2015), Gong, C., & Kim, S. (2018), González, G. H., Rendón, A. H., & Restrepo, A. M. P. (2012). Mora-Mora, J. U. (2016).

Mainly we can highlight the prevailing consensus about the lack of evidence of the existence of a common economic cycle for Latin American countries, i.e., there has not been full convergence. Even so, there are relevant correlations between pairs of countries. This would lead one to think that there is a greater correlation of economic cycles among them, even sub regional synchronization, as shown by the results obtained. The relationship between trade and the business cycle is the most important aspect of synchronization, and regional trade integration has a positive effect on the synchronization of regional business cycles.

4.3.2 Business cycle synchronization with its main trade partners

The Ecuadorian economic cycle is strongly conditioned by the fact that it is an economy with a high degree of openness and dependence on the price of its main exports. Therefore, to the analysis made in the previous section, we will add the results of comparing the Ecuadorian cycle with that of its main trading partners, which are the USA, the European Union, China and Russia. Being the first two historical partners of the country and the next two countries that have increased the volume of imports from Ecuador, representing about 70% of Ecuador's exports, as we can see in Figure 4.

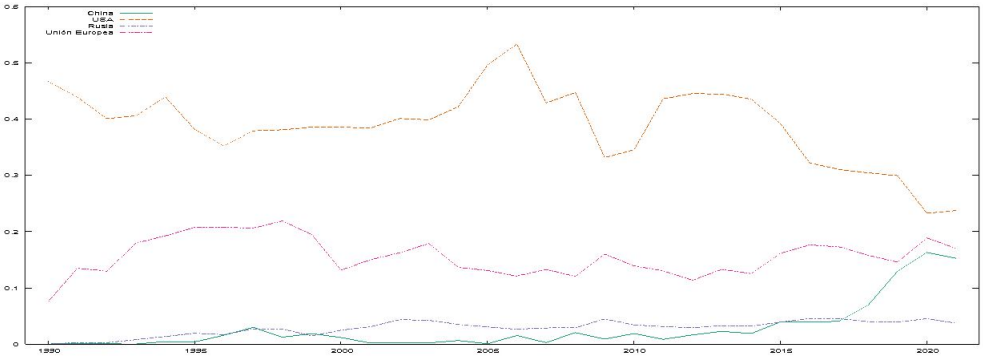

Figure 4: Percentage of the total Ecuadorian exportation by country of destination (1995-2020)

Figure 5 shows the cyclical components of the Ecuadorian economy together with those of the selected countries. As we can see, the cycle according to the HP filter has a certain concordance with the selected economies. We find important differences with respect to the cyclical behavior with the rest of the economies, being the cycles of the USA and the European Union the least similar to the national cycle, on the other hand, China and Russia seem to show a closer behavior.

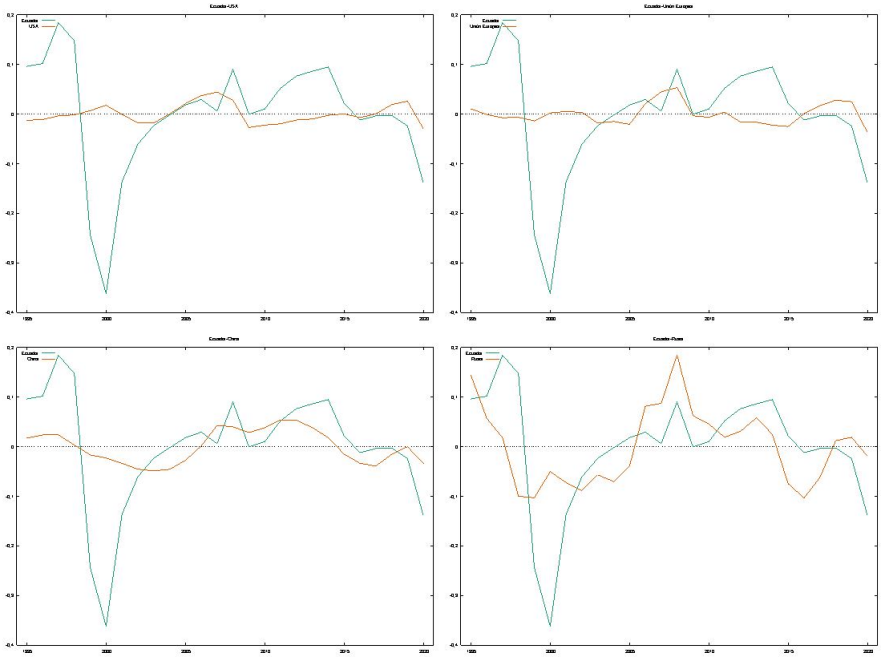

Figure 5: Comparison of the Ecuadorian cyclical component with its worldwide trade partners (1995-2020)

Table 4 shows the volatility of the cyclical components for the period analyzed. As we can see, the variability of the Ecuadorian cycle is not comparable to that of the USA and the European Union, which have very mild cycles over time. Even Russia's volatility is lower, being the most volatile of the countries analyzed. Considering the relative volatility with respect to Ecuador, we observe that in all countries the cyclical fluctuations are lower.

Table 4: Volatility of the Cyclical Component (1995-2020)

	Standard deviation	Relative deviation
Ecuador	0.117	1.000
United States of America	0.020	0.168
European Union	0.021	0.183
China, P.R. of	0.034	0.286
Russian Federation	0.078	0.663

Table 5 shows the cross-correlation matrix between the different cyclical components extracted through the use of the HP filter. As we can see, the correlation with the cyclical component of China is relatively high, at 0.514, and they move synchronously. Something similar occurs with the degree of interrelation with the Russian economy, although in this case it is observed that the Ecuadorian cycle is delayed by one period.

In the case of the United States and the European Union, the coefficients are low, so there does not seem to be a stable relationship between these economies and the Ecuadorian economy. In addition, in the case of the USA we observe an asymmetry in the cycles and a delay of one period and with respect to the EU it is four periods ahead.

Table 5. Correlations of the GDP cyclical component (1995-2020)

	$t-4$	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
USA	0.139	-0.023	-0.169	**-0.209**	-0.091	-0.052	0.164	0.163	-0.039
EU	0.079	0.067	0.048	0.026	0.082	-0.154	-0.084	0.121	**0.198**
China	-0.053	0.045	0.207	0.398	**0.514**	0.427	0.359	0.265	0.136
Russia	-0.066	0.207	0.459	**0.529**	0.441	0.178	0.117	0.003	-0.062

The results of this paper provide support for the conventional wisdom that globalization leads to an increase in the degree of synchronization of business cycles. We find that trade and market integration increase macroeconomic fluctuations, which has important implications for the conduct of macroeconomic policies in an increasingly integrated world economy.

4.4 Conclusions

Having made a comparison between the economic cycle of Ecuador and that of the CAN countries, we obtained that the correlation between the economic cycle of Ecuador and these countries has followed a synchronization trend that intensified after the implementation of the trade agreements reached in 1994, which eliminated trade barriers. There is currently a very similar economic cycle between Ecuador, Colombia and Peru. This result is logical given not only that the countries share extensive borders and have strong trade links, but also that their productive structures are similar. In other words, the cycles of the Latin American economies now seem to be more in line with international shocks related to the rise of the Chinese and Russian economies, but also strongly linked to the U.S. and European economies. This is consistent with a region that is increasingly integrated with the Chinese economy as the Latin American region is now. In that sense, the Latin American region as a whole is highly dependent on external development, especially since the great recession of 2008. There is a clear dominance of trade flows over financial flows as determinants of business cycle movements in the short term. Latin America's linkage with respect to the most advanced economies seems to have been determined

not only by the increase in trade flows to China, but also by a low degree of financial integration with its main economic partners.

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Chapter 5

Oil price shocks, government revenues, and public investment: The case of Ecuador

This paper studies the macroeconomic consequences of oil price shocks for small oil-exporting countries as a function of the adopted specific fiscal policy rule related to oil revenues. We focus on the particular case of Ecuador, where a large fraction of government revenues depends on oil revenues and where a fiscal policy rule implemented in 2008 establishes that public investment is a function of oil revenues. The paper develops a simple two-sector model featuring some key characteristics of the Ecuadorian economy to study the effects of international oil price shocks on macroeconomic volatility and welfare. The paper investigates alternative simple and easy practical implementation of fiscal rules related to oil revenues and compares their effects on economic activity and welfare to the existing rule. We argue that a slight modification of the current fiscal rule, by linking public investment to all government revenues and not only to oil revenues, would significantly reduce the volatility of the Ecuadorian economy and cut the welfare cost of oil price shocks.

5.1 Introduction

Oil price volatility has important macroeconomic consequences for both oil-importing and oil-exporting countries. Traditionally, it has been observed that in oil-importing countries, real output growth, employment, and inflation are very sensitive to fluctuation in the world price of oil; in these economies oil fuel represents a significant fraction of total energy consumption.[1] On the other hand, rich endowment of commodity resources can have both positive and negative consequences for the economy, particularly in relatively small countries.[2] Oil-exporting countries face a budget dependency on price shocks in international markets causing oil revenue windfalls, which are one source of procyclicality in fiscal policy and macroeconomic fluctuations. This is particularly important in small developing oil-exporting countries, where the public budget depends heavily on oil revenues, and the way in which oil windfalls are managed is a key transmission mechanism of oil price fluctuations (Mehara and Oskouri, 2007; Villafuerte et al., 2010; Erbil, 2011; Pieschacón, 2012;

[1] See, for instance, Barsky and Kilian (2004), Blanchard and Gali (2007), Kilian (2008), and Balke and Brown (2018).

[2] Natural resources can be a source of income and economic growth but also the opposite. This second phenomenon has been named by the literature as the resource curse, the paradox of plenty, or the Dutch disease (Corden and Neary, 1982; Arezki and Ismail, 2003, Mehara, 2009). Sach and Warner (1995) prove that economies with abundant natural resources have tended to grow less rapidly than those with scarce natural resources during the 1970s and 1980s.

Arezki and Ismail, 2013; Hou et al., 2016; García-Albán et al., 2021). Importantly, the transmission mechanism from oil price shocks to the rest of the economy depends on how oil windfalls are managed by the government. Fiscal rules related to oil revenues and oil funds have been established by several oil exporting countries with two main objectives: saving a fraction of oil revenues for future generations and macroeconomic stabilization.

A number of works have studied the implications of alternative fiscal policies in commodity producing countries, focusing on the experiences of Norway, Chile, and Mexico, studying the effects of price fluctuations of international commodities on macroeconomic volatility and fiscal policy procyclicality (Schmitt-Grohé and Uribe, 2007; García et al., 2011; Pieschacón, 2012; Kumhof and Laxton, 2013; Snudden, 2016). Talvi and Végh (2005) study a sample of 56 countries (both developed and developing) and find that whereas fiscal policy in the G7 countries appears to be acyclical, fiscal policy is found to be procyclical in developing countries, mostly in economies with rich endowments of commodities. Frankel (2011) shows that procyclical fiscal policies have been a general problem in Latin American commodity-exporting countries. He studies the case of Chile, an economy very sensitive to fluctuations in the international price of cooper, where fiscal policy has been governed since 2000 by a structural budget rule that has succeeded in implementing countercyclical fiscal policies. Guerra-Salas (2014) studies the case of Mexico and compares a policy where the government consumes and invests all oil windfalls with a prudent policy based on a sovereign fund. He finds that a positive oil price shock generates an expansion in consumption and investment and that the prudent policy can isolate the economy from oil price volatility. Pieschacón (2012) demonstrates that fiscal policy design in oil-exporting countries is key in the transmission mechanism of oil price shocks to the economy, propagating or isolating the economy from oil price volatility. She compares fiscal policy in two oil-exporting countries, Mexico and Norway, with different fiscal policy schemes related to oil revenues, resulting in different outcomes depending on the scheme adopted for managing the oil revenues. Berg et al. (2013) study the role of fiscal policies in commodities exporting developing countries, comparing a public investment fiscal rule with a sovereign wealth fund in managing windfalls from exporting of resources. In particular, they study the cases of Angola and the CEMAC region (Central Africa Economic and Monetary Community), proposing a sustainable investing policy as a combination of investment with a resource fund to gain macroeconomic stability and accelerate economic development. Bergholt et al. (2019) quantify the importance of oil price shocks for Norway and find that oil price fluctuations are an important source of macroeconomic volatility and that the domestic oil industry supply chain is an important transmission mechanism for oil price movements. The fact that Norwegian fiscal authorities accumulate oil income in a sovereign wealth fund implies substantial protection against oil price shocks.

This paper studies the implications of oil price shocks for oil-exporting countries as a function of fiscal policy related to oil revenues, focusing on the case of Ecuador. Ecuador is an oil-producing economy featuring some particular characteristics that closely link the oil sector to the fiscal policy. The paper quantifies the impact on macroeconomic volatility and welfare from the fiscal policy related to oil revenues implemented by Ecuador, and contributes to the literature by comparing alternative rules for fiscal policy related to oil revenues and their implications for the transmission mechanism of oil price volatility in oil-exporting countries to macroeconomic fluctuations and welfare. While many oil-exporting countries (e.g., Mexico, Norway, and Middle Eastern countries) have adopted a wide range of public funds designed

to stabilize the economy against oil price fluctuations, in the case of Ecuador this type of instrument was discarded due to an urgent need of the government to foster economic growth with expansive fiscal policies. Since 1998, a number of oil fund programs have been successively created in Ecuador for specific uses of oil revenues with little success. Generally, the creation of these oil programs was followed by a series of new fiscal rules, mainly aimed at controlling the fiscal deficit by introducing limitations on primary expenditure growth. The purpose of these funds was mainly to finance priority infrastructure, education and health projects, and they were also used to purchase public external debt. Nevertheless, with the 2008 Constitution and due to the excessive fiscal rigidity of the country, all oil funds were eliminated by means of the Law for the Recovery of the Public Use of the State's Oil Resources and Administrative Rationalization of the Indebtedness Processes. This new law establishes that all public resources coming from oil must enter the general budget as capital revenues and must be solely and exclusively used for investment purposes. This fiscal rule introduces a new transmission mechanism from oil price shocks to capital accumulation, as public investment is constrained by oil revenues. All these factors have contributed over time to increasing macroeconomic fluctuations and an excessive dependency of capital formation on the international oil barrel price.

First, we study the effects on the business cycle of an oil price shock given the current fiscal rule related to oil-revenues implemented by Ecuador. A positive oil price shock increases public revenues and, given the oil fiscal rule, also increases public investment. As a consequence, the shock increases total output but generates crowding-out effects on the non-oil sector. We compare the effects of the shock with three alternative fiscal rules: a fiscal rule where public investment is a function of total government revenues, a second fiscal rule where public investment is a function of permanent oil revenues, and a third fiscal rule where oil windfalls are not included in the public budget but accumulated into a fund. These alternative fiscal rules related to oil revenues only require a slight change to the current fiscal rule where public investment is a function of oil revenues. We find that the transmission mechanism from oil price shocks to macroeconomic fluctuations changes dramatically depending on the particular oil revenues fiscal rule. The model is simulated and some moments are used to investigate how oil price shocks generate volatility in the economy depending on the fiscal rule. We find that with the three proposed alternative rules, the transmission mechanism is significantly damped and macroeconomic fluctuations are significantly reduced compared to the current fiscal rule. Finally, we evaluate the welfare consequences of oil price shocks depending on the oil revenues fiscal rule implemented by the government. Welfare losses due to oil price fluctuations are high with the current fiscal rule. We show that the adoption of any of the three alternative fiscal rules, considerably reduces the welfare losses due to oil price shocks.

The structure of the rest of the paper is as follows. Section 2 presents a simple dynamic stochastic general equilibrium (DSGE) model describing the key features of the economy of Ecuador. Section 3 calibrates the parameters of the model according to key ratios for the Ecuadorian economy. Section 4 uses the calibrated model to assess the effects of a world oil price shock. Section 5 studies the transmission mechanism of an oil price shock depending on alternative fiscal rules related to oil revenues. Section 6 evaluates welfare under the alternative fiscal rules. Finally, Section 7 concludes.

5.2 A two-sector model for the Ecuadorian economy

We build a simple real business cycle-type DSGE model featuring some key characteristics of the economy of Ecuador: the existence of a state-owned oil production sector, where oil exploitation, extraction and export are done by the government with a technology using public capital and labor, a fiscal rule linking public investment to oil revenues, and no monetary policy. The model economy considers two sectors: a privately managed non-oil sector and a publicly managed oil sector. Non-oil sector technology uses labor, private capital and non-oil public capital as inputs. Labor and public capital inputs are distributed across the two sectors. The economy is populated by a representative household that has preferences regarding consumption and leisure. The government finances lump-sum transfers by collecting taxes and public investment using oil revenues. Finally, there is no monetary policy nor exchange rate changes as Ecuador has de facto no currency, and has instead been a dollarized economy since 2000.

5.2.1 Households

We consider an economy inhabited by an infinity-lived household. Households' maximize the expected discounted inter-temporal utility function defined over consumption, $\{C_t\}_{t=0}^{\infty}$, and labor, $\{L_t\}_{t=0}^{\infty}$. The following utility function accommodates these preferences,

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\log C_t - \phi \frac{L_t^{1+1/v}}{1+1/v} \right] \tag{5.1}$$

where β is the discount factor, E_0 is the conditional expectation operator evaluated at time 0, v is the Frisch labor elasticity parameter, and $\phi > 0$ is a parameter representing the relative preference for leisure over consumption (household' willingness to work). Total labor is split between the two sectors: non-oil sector labor, $L_{s,t}$, and oil sector labor, $L_{o,t}$,

$$L_t = L_{s,t} + L_{o,t} \tag{5.2}$$

By renting labor and physical capital to the firms in the non-oil sector, households get labor and capital income. Additionally, they obtain labor income for devoting hours to the oil sector. The budget constraint is given by:

$$(1+\tau_t^c)C_t + I_{s,t} = (1-\tau_t^l)W_{s,t}L_{s,t} + (1-\tau_t^l)W_{o,t}L_{o,t} + (1-\tau_t^k)R_tK_{s,t} + Tr_t + (1-\tau_t^{\pi})\Pi_{s,t} \tag{5.3}$$

where $I_{s,t}$ denotes private investment, $K_{s,t}$ is the capital stock in the non-oil sector, $W_{s,t}$, and $W_{o,t}$ are the wages in the non-oil and oil sectors, respectively, R_t is the rental price of private capital, Tr_t is a lump-sum transfers, and $\Pi_{s,t}$ represents profits from the non-oil firms. The model includes four taxes: the consumption tax, τ_t^c, the labor income tax, τ_t^l, the capital income tax, τ_t^k, and a profits tax, τ_t^{π}. Private physical capital stock holdings evolve according to the following law of motion,

$$K_{s,t+1} = (1-\delta_s)\, K_{s,t} + I_{s,t} \tag{5.4}$$

where $0 < \delta_s < 1$ is the fixed depreciation rate of physical capital in the non-oil sector.

Households maximize expression (1) subject to (2), (3), and (4). From the first order conditions, we obtain the following equilibrium conditions for labor supply

and optimal investment choices,

$$\phi L_t^{1/v}(1+\tau_t^c)C_t = (1-\tau_t^l)W_{s,t} \tag{5.5}$$

$$\phi L_t^{1/v}(1+\tau_t^c)C_t = (1-\tau_t^l)W_{o,t} \tag{5.6}$$

$$\frac{(1+\tau_{t+1}^c)E_tC_{t+1}}{(1+\tau_t^c)C_t} = \beta E_t\left[(1-\tau_t^k)R_{t+1}+1-\delta_s\right] \tag{5.7}$$

Equilibrium conditions (5), (6) and (7) are necessary conditions for an optimal solution. Equation (5) is the optimal labor supply in the non-oil sector, equation (6) is the equivalent optimal condition for the oil sector, and equilibrium condition (7) is the optimal consumption path (Euler equation for the accumulation of private capital). These conditions, along with the accumulation equations, technology, resource constraint and transversality conditions, fully characterize the equilibrium of the model, given the price of productive factors, and taxes. Combining equilibrium conditions (5) and (6), we find that the household supply working time to each sector until $W_{s,t} = W_{o,t}$.

5.2.2 Non-oil sector firms

For simplicity, we assume a competitive environment for the non-oil sector. The problem for the firm is to find optimal values for the utilization of labor and capital given the technology. The production of final output, $Y_{s,t}$, requires labor services, $L_{s,t}$, private capital, $K_{s,t}$, and public capital, $K_{gs,t}$. The firm rents capital and hires labor from households and maximizes period-by-period profits, taking factor prices and public inputs as given. The technology exhibits a constant return to scale; hence the profits are positive equilibrium, as firms do not pay the cost of use of public capital. The Cobb-Douglas technology used by the firm is:

$$Y_{s,t} = A_tK_{s,t}^{\alpha}K_{gs,t}^{\gamma}L_{s,t}^{1-\alpha-\gamma} \tag{5.8}$$

where α is the capital share of output, γ is the output-public capital elasticity, and A_t is a measure of aggregate productivity. The problem for the firm is to maximize period-by-period profits:

$$\Pi_{s,t} = A_tK_{s,t}^{\alpha}K_{gs,t}^{\gamma}L_{s,t}^{1-\alpha-\gamma} - W_{s,t}L_{s,t} - R_tK_{s,t} \tag{5.9}$$

From the profit maximization problem we obtain the following two first order conditions:

$$W_{s,t} = (1-\alpha-\gamma)A_tK_{s,t}^{\alpha}K_{gs,t}^{\gamma}L_{s,t}^{1-\alpha-\gamma} \tag{5.10}$$

$$R_t = \alpha A_tK_{s,t}^{\alpha-1}K_{gs,t}^{\gamma}L_{s,t}^{1-\alpha-\gamma} \tag{5.11}$$

Therefore, profits are positive and given by contribution of public capital to output,

$$\Pi_{s,t} = \gamma Y_{s,t} \tag{5.12}$$

The technology in the non-oil sector is assumed to follow a stochastic process given by,

$$\log A_t = (1-\rho_A)\log A + \rho_A \log A_{t-1} + \varepsilon_t^A \tag{5.13}$$

where A is the steady-state value of the non-oil technology, ρ_A the persistence of the shock, and $\varepsilon_{A,t} \sim N(0,\sigma_A^2)$, is an independently and identically distributed random

variable.

5.2.3 Oil sector

The oil sector is ownership by the government, and hence, all capital input used in oil production is provided by the government. The oil production function use a combination of labor and public capital into a Cobb-Douglas type production function,

$$Y_{o,t} = B_t K_{go,t}^{\eta} L_{o,t}^{1-\eta} \tag{5.14}$$

where η $(0 < \eta < 1)$ represents the oil output to oil capital elasticity, and B_t is a measure of aggregate productivity in the oil production. Profits for the oil-producing firm is defined as,

$$\Pi_{o,t} = P_{o,t} Y_{o,t} - W_{o,t} L_{o,t} \tag{5.15}$$

where $P_{o,t}$ is the price of oil and where the only production cost is labor cost. Contribution to oil production by capital is costless and transformed into profits. The oil sector firm maximize profits subject to the technological restriction. From this profit maximization process, we find that equilibrium wages in the oil sector is given by,

$$W_{o,t} = (1-\eta) P_{o,t} B_t K_{go,t}^{\eta} L_{o,t}^{-\eta} \tag{5.16}$$

As the oil production firm uses public capital at no cost, profits are given by,

$$\Pi_{o,t} = \eta P_{o,t} Y_{o,t} \tag{5.17}$$

The technology in the oil sector is assumed to follow a similar stochastic process as in the non-oil sector, that is,

$$\log B_t = (1-\rho_B) \log B + \rho_B \log B_{t-1} + \varepsilon_t^B \tag{5.18}$$

where B is the steady-state value of the oil technology, ρ_B the persistence of the shock, and $\varepsilon_{B,t} \sim N(0, \sigma_B^2)$ is an independently and identically distributed random variable. Finally, the price of oil is exogenously given to the economy. Ecuador is a small economy and its oil production is relative small to world oil production. Hence, oil production fluctuations in Ecuador has no impact on the world oil price. As it is standard in the literature, we assume that oil price follows a first order auto regressive process AR(1) as follows:

$$\log P_{o,t} = (1-\rho_o) \log P_o + \rho_o \log P_{o,t-1} + \varepsilon_t^o \tag{5.19}$$

where $P_{o,t}$ is the steady-state value of oil price, ρ_o the persistence of the shock, and $\varepsilon_{o,t} \sim N(0, \sigma_o^2)$ is a stochastic component.

5.2.4 The Government

The government has an active role in the economy apart from taxing and spending, as the oil sector is public-owned. Public revenues comes from two sources: taxes and oil export revenues. Indeed, there are two separate government budgets, one of them specific to the oil sector. Total government revenues are defined as:

$$F_t = \tau_t^c C_t + \tau_t^l (W_{s,t} L_{s,t} + W_{o,t} L_{o,t}) + \tau_t^k R_t K_{s,t} + \tau_t^{\pi} \Pi_{s,t} + \Pi_{o,t} \tag{5.20}$$

where $\Pi_{o,t}$ are profits from the oil sector (oil revenues). On the expenditure side we consider two components: lump-sum transfers to the households, and public investment, $I_{g,t}$

$$G_t = Tr_t + I_{g,t} \tag{5.21}$$

imposing the following two additional restrictions according to the oil revenues-related fiscal rule used by the government:

$$T_t = \tau_t^c C_t + \tau_t^l (W_{s,t} L_{s,t} + W_{o,t} L_{o,t}) + \tau_t^k R_t K_{s,t} + \tau_t^\pi \Pi_{s,t} \tag{5.22}$$

$$I_{g,t} = \Pi_{o,t} \tag{5.23}$$

where T_t account for tax revenues, and where public investment is equal to oil revenues.

Given fiscal rules in the Ecuadorian economy, we assume that public budget is in equilibrium period-by-period. This balanced fiscal rule has been followed by the Ecuadorian fiscal authorities during the last decade, provoking dramatic changes in the public budget year to year. This is equivalent to assume that public deficit does not change in response to oil price shocks and instead government spending adjust to the new level of public revenues where oil windfalls are incorporated. The fiscal rule introduces a new transmission mechanism from oil price shocks to capital accumulation, as public investment is constrained by oil revenues.

Public investment transforms into public capital stock that is used as an input in both sectors, $I_{g,t} = I_{gs,t} + I_{go,t}$, according to the following law of motions:

$$K_{gs,t+1} = (1 - \delta_{gs}) K_{gs,t} + I_{gs,t} \tag{5.24}$$

$$K_{go,t+1} = (1 - \delta_{go}) K_{go,t} + I_{go,t} \tag{5.25}$$

where $K_{gs,t}$ is public capital in the non-oil sector and $K_{go,t}$ is public capital in the oil sector. Public investment is split between the two sectors according to the following exogenous rule:

$$I_{gs,t} = \theta I_{g,t} \tag{5.26}$$

$$I_{go,t} = (1 - \theta) I_{g,t} \tag{5.27}$$

where θ $(0 < \theta < 1)$ is the fraction of public investment allocated in the non-oil sector.

5.3 Calibration of the model

This section carefully calibrates the parameters of the model to a number of targets for the Ecuadorian economy, using data from the Central Bank of Ecuador, the World Bank, and the Penn World Table. We use data starting in 2000, mostly due to restrictions on data availability and to the fact that the Ecuadorian economy was subject to a structural change in 1999 with a dollarization process, and the de facto loss of monetary policy and the adoption of a fixed exchange rate with the US. The baseline parameters values are shown in Table 1.

Table 1: Calibration of the parameters

Parameter	Definition	Value
β	Discount factor	0.99
ϕ	Willingness to work	6.54
υ	Frisch elasticity	0.72
α	Non-oil output-capital elasticity	0.35
γ	Non-oil output-public capital elasticity	0.10
η	Oil output-public capital elasticity	0.833
δ_s	Non-oil capital depreciation rate	0.03
δ_{gs}	Non-oil public capital depreciation rate	0.025
δ_{go}	Oil public capital depreciation rate	0.035
θ	Public investment fraction non-oil sector	0.8525
ρ_o	Persistence of shock to oil price	0.92
ρ_A	Persistence of shock to TFP in the non-oil sector	0.95
ρ_B	Persistence of shock to TFP in the oil sector	0.95
τ^c	Consumption tax rate	0.12
τ^k	Capital income tax rate	0.25
τ^l	Labor income tax rate	0.122
τ^π	Profits tax rate	0.25
P_o	Oil barrel price	0.56
σ_o	Deviation oil price	0.16
σ_A	Deviation TFP non-oil sector	0.01
σ_B	Deviation TFP oil sector	0.01

First, we use data for oil revenues as a fraction of GDP, Π_o/Y, as a target for the calibration of the technological parameters for oil capital in the oil production function. In the particular case of Ecuador, oil export revenues are a significant fraction of total exports (32%), total public revenues (28%), and account for about 12% of GDP. According to World Bank data, average public revenue from oil production as a percentage of GDP was 0.0996 in Ecuador for the period 1980-2017. This figure fluctuates year to year mainly depending on international oil prices, and is calculated as total revenues minus the production cost of oil as a percentage of GDP. On the other hand, oil output represents around 12% of total GDP in Ecuador. Using these figures, we find that $\eta = 0.0996/0.12 = 0.833$. This result in a high value for the elasticity of oil capital to oil production, indicating that 83.3% of total oil income correspond to capital, whereas the remaining 16,7% corresponds to labor, given the assumed Cobb-Douglas production function. The labor share is calculated using data from the Penn World Table, as the average for the period 2000-2019, resulting a value of 0.55. Hence, for the non-oil sector, the elasticity of output with respect to private capital is fixed to $\alpha = 0.35$, whereas the elasticity of output with respect to public capital elasticity is fixed to $\gamma = 0.1$. The household's discount factor, β is fixed to 0.99, which corresponds to an annual interest rate of around 4%. The public investment $I_g = (\Pi_o/Y) = 0.1$ and the proportion of public investment allocated to the non-oil sector is given by the parameter $\theta = 0.8525$.

The parameters driving labor supply are fixed as follows. First, for the Frisch elasticity of labor supply, υ, we use a value of 0.72 as proposed by Heathcote et al., (2010). Given this value, we use the fact that the average number of hours worked for the period 1995-2016 is 1,815 hours as a target. Assuming a total available time of 5,000 hours per year (considering 6 working days per week and a total of 16 hours available each day), the fraction of working hours over total hours is 0.363. Given this target, the willingness to work parameter is chosen internally just to produce

that figure, resulting in a calibrated value for the parameter ϕ of 6.54. Depreciation rates are fixed at δ_s =0.03 for private capital, δ_{gs} =0.025 for public capital in the non-oil sector, and δ_{go} =0.035 for public capital in the oil sector.

For the parameters denoting tax rates $\tau^c, \tau^l, \tau^k, \tau^\Pi$ we use values which are consistent with the Ecuadorian Law known as the Internal Tax Regime (LORTI). The parameters for the oil price autoregressive process have been estimated using historical oil prices for the West Intermediate Texas oil, resulting in an autoregressive parameter of $\rho_0 = 0.92$, and $\sigma_o = 0.16$. Autoregressive processes of aggregate productivity parameters are calibrated using standard values in the literature. The value of the steady-state oil price P_o was calculate as $P_o = \Pi_o/(\eta Y)$. Finally, steady-state values for A and B are normalized to 1.

5.4 Quantitative simulations: Oil price shock

The calibrated model is simulated to study the consequences of a positive oil price shock on the economy in the current scenario, given the fiscal rule implemented by Ecuador that links public investment to oil revenues. How this shock is transmitted to the whole economy, depends on how the government manages the additional oil revenues and how they affect the government budget. García-Albán et al. (2021) estimate a structural autoregressive model to study the effects of fiscal policy and oil revenues shocks in the Ecuadorian economy, and find that oil revenues shocks have been the most important force driving output growth.

Figure 1 plots the impulse-response of key variables of the model to a positive (one standard deviation) oil price shock under the fiscal rule implemented by Ecuador from the year 2008. As expected an international rise in the price of oil leads to an instantaneous increase in government oil revenue, which is fully expended in public capital formation. A fraction of this additional oil revenue is expended in public capital in the oil producing sector, while the remaining is transformed into public capital to be used by firms in the non-oil sector. This creates two channels of transmission of the shock to the economy. The first channel results from the higher capital input in the oil sector, leading to an instantaneous expansion of oil production. The second channel results from the higher level of public capital used in non-oil production activities, which increases the profits of private firms. However, the fiscal policy produces a crowding out effect on private activities. This crowding out effect is observed in both private investment and labor. The rise in public investment is accompanied by a decline in private investment during some periods, although after some time the response turns out to be positive, expanding private investment and hence, increasing private capital stock. On the other hand, the increase in working hours in the oil sector is accompanied by a decline in working hours in the rest of the economy, although total working hours remain almost constant.

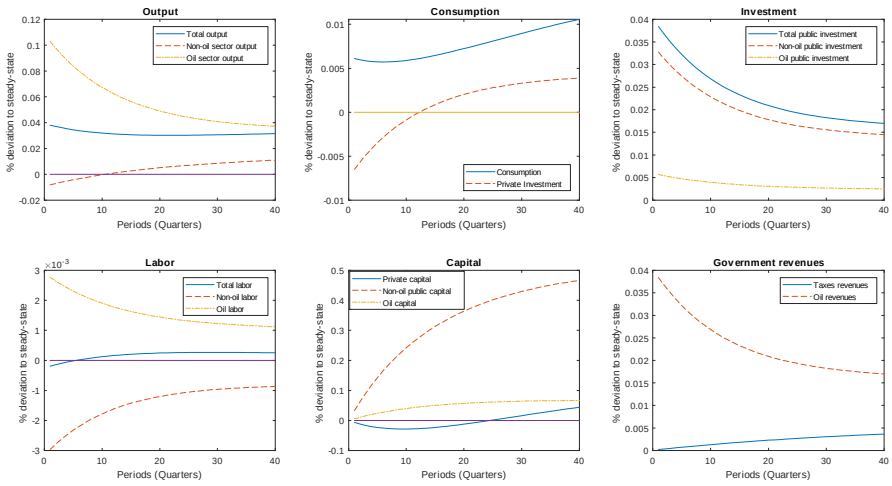

Figure 1: Impulse-response functions to a positive oil price shock.

The initial crowding out effect of fiscal policy has a negative impact on private output, although the total output of the economy expands thank to the increase in oil production. However, we observe a negative effect on private output in the first ten quarters, which becomes an expansion of private output in the following periods. Consumption expands mainly due to the crowding out effect that reduce private investment during the first quarters after the shock, where the substitution effect predominates. However, after some time, the income effect takes over, causing consumption to expand further. The expansion of the economy leads to a rise in taxes revenues which contribute to expanding the public budget, along with the higher oil revenues.

Finally, it is observed that the effects of the shock are highly persistent. This high persistence is explained not only by the persistence of the shock, but also by the initial crowding out effect of the shock, by the posterior positive effects once additional public capital has been built, and also by the high persistence induced by the fiscal rule, which causes accumulation of public capital. The fiscal rule related to oil revenues implemented by Ecuador not only directly translates any oil price shock to the economy, but also fosters its persistence through the accumulation of public capital.

5.5 Rethinking the oil-revenues fiscal rule

Fiscal rules by oil-producing countries can be classified into two types. In the first type, countries implement fiscal rules in which the government budget is a function of oil revenues. In this case, fiscal policy is linked to international oil price fluctuations, and hence, dependent on supply and demand shocks in the oil international market. This is the case for Ecuador and other developing oil producing economies (García-Albán et al. 2021). In the second type, fiscal policy is isolated from fluctuations in oil prices by collecting the oil revenues in an investment fund. This is the case for Norway (see Pieschacón, 2012; Tabarrei et al., 2018; Bergholt et al., 2019, among others).

This section explores alternative fiscal rules related to oil revenues and compares their consequences for the economy to the existing fiscal rule implemented since 2008 in Ecuador. We focus on simple rules that require only slight modifications of

the current one and that are easy to implement and politically feasible. The proposed alternative fiscal rules are the following:

5.5.1 Fiscal rule A

First, we consider a slight modification in the public investment rule implemented by the government. This modification consists in linking public investment not only to oil revenues but to total government revenues, F_t, including both taxes levies and oil revenues. This new fiscal rule is defined as:

$$I_{g,t} = \mu F_t \tag{5.28}$$

where μ $(0 < \mu < 1)$ is the fraction of total public revenues devoted to public investment. This fiscal rule implies that oil windfalls are proportionally distributed among the different components of public spending, and hence, public investment depends not only on oil revenues, but also on tax revenues. We calibrate this fraction just to keep the public investment ratio constant at the value resulted from the benchmark public investment rule in steady state. Given that under the benchmark fiscal rule, public investment is equal to oil revenues $(\Pi_o = Ig)$, which is, on average, a 10% of GDP $(Ig/Y = 0.1)$, and given that the ratio of total government revenues to GDP has been 36% on average during the last 10 years, these figures results in a value of $\mu = 0.1/0.36 = 0.277$. This value is relatively high, indicating that close to 28% of total government revenues is devoted to capital formation, leaving the remaining 72% for transfers to households.

5.5.2 Fiscal rule B

This second alternative fiscal rule consists in linking public investment to permanent oil revenues. Oil revenues can be decomposed into a permanent component and a transitory one,

$$\Pi_{o,t} = \Pi_o + \Pi_{shock,t} \tag{5.29}$$

where Π_o is the long-run oil revenues for the equilibrium oil price, and $\Pi_{shock,t}$ are positive or negative oil windfalls depending on fluctuations in the international oil price. Formally, this fiscal rule can be defined as,

$$I_{g,t} = \Pi_o \tag{5.30}$$
$$Tr_t = T_t + \Pi_{shock,t} \tag{5.31}$$

Under this scenario, public investment is constant and equal to oil revenues in the long-run, and is hence isolated from changes in the international oil market. The positive or negative oil windfalls (as the deviation of the long-run value) are incorporated into the public budget and expended as lump-sum transfers to households.

5.5.3 Fiscal rule C

The last fiscal rule is similar to the previous one except for the fact that oil windfalls are not included in the public budget but accumulated in an investment fund. Formally, this fiscal rule can be defined as,

$$I_{g,t} = \Pi_o \tag{5.32}$$
$$Tr_t = T_t \tag{5.33}$$

where transfers are equal to taxes revenues and therefore, current public expenditures are not affected by oil price shocks. Likewise, public investment remains constant over the business cycle.

Figures 2 and 3 plot the impulse-response functions of the key variables following a positive oil price shock under the four alternative fiscal rules. Interestingly, the impulse-responses under fiscal rule A and C are very similar, indicating that both fiscal rules, although of very different nature, lead to a similar response of the economy to an oil price shock. The reason why rule B provokes a different behavior of the economy compared to rule C is that under the former, oil windfalls are included in the lump-sum transfers. Overall, we find that the deviations from equilibrium of the key variables provoked by the shocks are lower under the three alternative fiscal rules compared with the current public investment fiscal rule related to oil revenues.

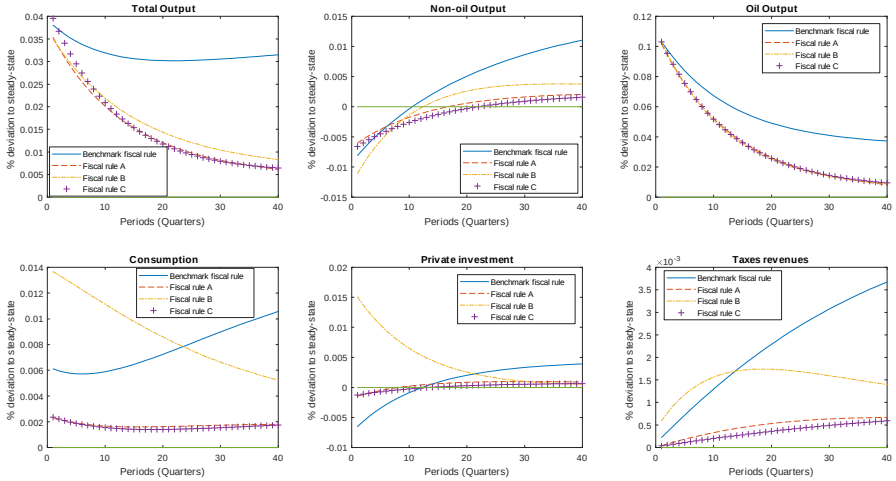

Figure 2: Impulse-response functions to a positive oil price shock under alternative oil revenues-related fiscal rules (I).

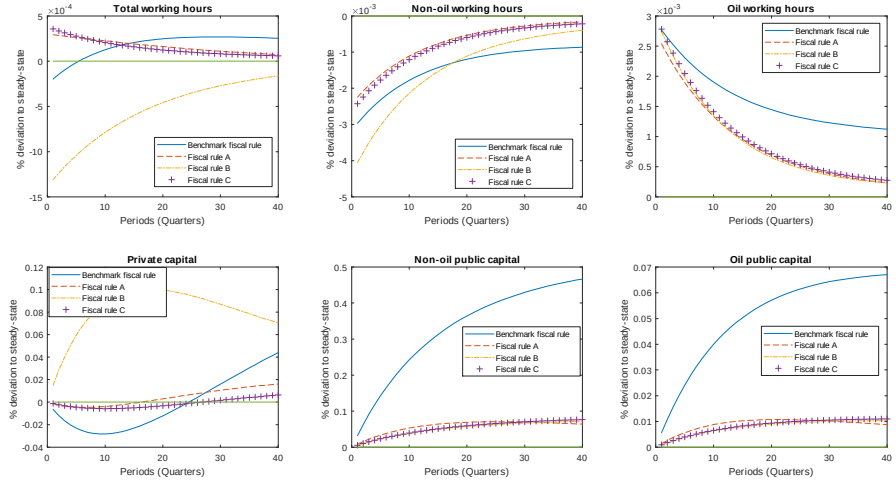

Figure 3: Impulse-response functions to a positive oil price shock under alternative oil revenues-related fiscal rules (II).

Table 2 shows some key moments (standard deviation and correlation to output) for the baseline and the alternative fiscal rules. The output standard deviation in the current scenario is dramatically high. This is a consequence of the high volatility

shown by oil prices, volatility that is aggravated by the baseline fiscal rule, which is translated directly to the rest of the economy through the public capital formation process. This baseline fiscal rule not only translates any oil price variation to the rest of the economy and amplifies it, but also increases the persistence of the shock due to the designed public investment rule. Among the alternative fiscal rules proposed, rule A has better performance in terms of stabilization of the economy, reducing the volatility of the total output by a factor of five, the non-oil output by a factor of four, and the oil output and public investment by a factor of around 10. Hence, it is shown that when the oil output revenues are part of the government general budget instead of going directly into investment, the overall volatility of the economy decreased. Rules B and C have similar results each other, with both greatly reducing the volatility of the economy but in a lesser extent than rule A.

Table 2: Simulated moments from the model

	Benchmark rule		Fiscal rule A		Fiscal rule B		Fiscal rule C	
	S.D.	Corr.	S.D.	Corr.	S.D.	Corr.	S.D.	Corr.
Total output	41.69	1.00	7.94	1.00	10.52	1.00	10.67	1.00
Non-oil output	22.67	0.97	5.45	0.54	6.80	0.72	6.76	0.71
Oil output	173.85	0.99	16.41	0.78	33.86	0.84	35.83	0.85
Consumption	27.01	0.99	4.36	0.74	7.73	0.97	6.44	0.87
Private investment	23.52	0.91	10.18	0.57	13.87	0.81	11.13	0.62
Public investment	184.70	0.97	16.99	0.90	33.88	0.84	35.82	0.85
Labor	0.82	0.72	0.82	0.69	1.34	-0.23	0.82	0.58
Non-oil labor	5.91	-0.93	2.09	-0.51	3.53	-0.61	2.35	-0.61
Oil labor	158.10	0.96	52.70	0.74	56.08	0.77	58.78	0.78
Tax revenues	25.67	0.98	4.97	0.70	6.93	0.90	6.72	0.83
Government spending	72.15	0.99	7.04	0.99	13.93	0.92	14.24	0.91

To assess the relative importance of oil price shocks to the Ecuadorian economy under the current and alternative fiscal rules, we simulate the model considering aggregate productivity shocks to each of the two sectors of the economy in addition to the oil price shock. The variance decomposition results for the baseline rule and for the alternative fiscal rules A, B and C are shown in Table 3. It is important to notice how predominant the oil price shock is compared to the productivity shocks in explaining output volatility. This can be specially observed under the effects of the current fiscal rule related to oil revenues in Ecuador. By contrast, the estimated relative importance of oil price shocks in explaining macroeconomic volatility diminishes when the alternative fiscal rules are adopted, in particular, for rule A. Overall, we find that any of the three alternative fiscal rules reduces the volatility of key macroeconomic variables in both the non-oil and the oil sector, and also reduces the volatility of both government revenues and expenditures. Based on all these results, the preferred alternative is fiscal rule A if the objective is to minimize fluctuations due to international oil price shocks.

Table 3: Variance decomposition of shocks

	Benchmark rule			Fiscal rule A			Fiscal rule B			Fiscal rule C		
	ε_o	ε_a	ε_b	ε_o	ε_a	ε_b	ε_o	ε_a	ε_b	ε_o	ε_a	ε_b
Total output	97.93	1.10	0.97	63.53	36.03	0.45	66.85	17.60	15.55	67.83	17.08	15.09
Non-oil output	94.26	4.80	0.94	6.57	93.39	0.05	32.38	56.59	11.03	31.72	57.14	11.14
Oil output	98.82	0.10	1.08	90.33	2.40	7.27	68.55	2.63	28.82	71.91	2.35	25.74
Consumption	97.13	1.91	0.97	11.65	88.25	0.10	63.93	23.93	12.14	48.06	34.36	17.48
Private invest.	83.56	15.61	0.83	3.24	96.73	0.03	43.51	53.64	2.84	12.16	83.42	4.42
Public invest.	98.95	0.09	0.96	94.36	5.00	0.64	68.55	2.63	28.82	71.91	2.35	25.74
Labor	54.09	45.38	0.53	18.49	81.40	0.11	67.51	32.12	0.37	14.94	84.08	0.97
Non-oil labor	96.50	2.57	0.93	80.52	18.93	0.55	89.78	7.52	2.71	76.75	17.10	6.16
Oil labor	98.83	0.22	0.95	98.81	0.54	0.65	90.63	1.79	7.58	91.41	1.64	6.95
Taxes revenues	96.03	3.02	0.96	7.56	92.38	0.06	43.13	43.19	13.67	39.51	45.95	14.55
Public spending	98.82	0.21	0.97	59.21	40.37	0.42	67.98	5.71	26.31	69.39	5.46	25.15

5.6 The welfare cost of oil price shocks

Fluctuations in economic activity and macroeconomic aggregates cause welfare costs for households. These welfare costs could be even more significant for commodity-exporting developing countries, where international price shocks of commodities enter as an additional source of fluctuations. The question here is how business cycle fluctuation provoked by oil price shocks in combination with fiscal policies related to oil revenues affects welfare. For that, we compare households' utility in a situation with no fluctuations (the steady state), with their utility under a scenario with oil price and productivity shocks and alternative scenarios with fiscal policies related to oil revenues. Utility in the steady state is defined as,

$$\sum_{t=0}^{\infty} \beta^t U(C, L) = \frac{1}{1-\beta} U(C, L) \tag{5.34}$$

where C, and L represents steady-state values for consumption and labor, respectively. We measure the cost of oil price shocks in consumption equivalent variation, that is, we calculate by how many percentage points we would have to increase or decrease the consumption of a household living in the steady state, without any change in oil prices, so as to make the household as well off as a household living in a world with oil price shocks (scenario denoted by O). We do that by solving the following equation,

$$\frac{1}{1-\beta} U((1+\Delta^O)C, L) = \sum_{t=0}^{\infty} \beta^t U(C_t, L_t; O) \tag{5.35}$$

where $\Delta^O 0$, represents the change (positive or negative) in consumption for each fiscal policy rule related to oil revenues. Using a first-order Taylor expansion of the utility in the new steady state when the change in the fiscal policy rule takes place, the above equations can be written as,

$$U(C, L) + U_C(C, L) C \Delta^O = E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t; O) \tag{5.36}$$

where $U_C(\cdot)$ represents the marginal utility of consumption in the steady-state. From the above expressions, the consumption equivalent variation can be calculated as,

$$\Delta^O \approx \frac{E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t; O) - U(C, L)}{U_C(C, L)C} \tag{5.37}$$

For each fiscal policy rule we simulate the model and calculate the expected level of utility. We do that by calculating the average of all utility levels in each simulated period for the four alternative scenarios. Table 4 summarizes the estimated welfare cost of economic fluctuations depending on the specific fiscal policy rule related to oil revenues implemented by Ecuador. We calculate the welfare cost from an oil price shock and from all shocks for each fiscal rule. Under the current fiscal rule, welfare losses are significant with a welfare loss of 2.84% from oil price volatility with respect to the steady state, and an aggregate loss of 3.63% when all three shocks are considered. By contrast, the three alternative fiscal policy rules related to oil revenues strongly mitigate welfare losses, and even oil price shocks turn out to have no effects on welfare. Considering all three shock, welfare losses are 0.09% for rule A, -0.26% for rule B, and -0.17% for rule C, whereas the welfare losses from the oil price shock are close to zero for the three alternative fiscal rules related to oil revenues.

Table 4: Welfare analysis

Welfare losses (consumption equivalent variation)		
	All shocks	Oil price shock
Baseline Fiscal Policy	-3.6275	-2.8382
Alternative Policy A	-0.0902	0.0061
Alternative Policy B	-0.2628	0.0019
Alternative Policy C	-0.1706	0.0794

5.7 Conclusions and policy implications

This paper studies the transmission mechanism of oil price shocks to the rest of the economy in a small oil-exporting country depending on the fiscal rule related to oil revenues followed by the government. In particular, the paper focuses in the case of Ecuador, where the oil sector is government-ruled, oil revenues represent a significant fraction of the public budget, and the government implements a oil revenues fiscal rule that closely link public investment to oil revenues, separated from taxes revenues which are used for current spending.

The analysis done in this paper and the results therein have clear policy implications for the design of fiscal policies related to oil revenues in some developing economies where the use of an investment fund such as the scheme used by Norway is controversial and has little room for practical implementation due to institutional factors. We show that the fiscal rules followed by the Ecuadorian fiscal authorities, namely a budget equilibrium year by year, and a public investment rule where public investment is equal to oil revenues, reinforces the transmission mechanism from international oil price shocks to macroeconomic fluctuations, increasing the volatility of key macroeconomic variables and reducing welfare. However, the current scenario of high macroeconomic volatility and welfare cost could be reversed by introducing small and simple changes in the current public investment fiscal rule related to oil revenues.

We propose and evaluate three alternative fiscal rules that are simple and easy to implement practically and their economic consequences for macroeconomic fluctuations and welfare are compared to the current oil revenues-public investment fiscal rule. These alternative fiscal rules decouple public investment from oil windfalls and prove to be effective in reducing macroeconomic volatility provoked by international oil price shocks. The most adequate alternative seems to be a fiscal rule where public investment is a function of total public revenues, including both taxes and oil revenues. This alternative fiscal rule is simple and only requires a slight modification of the current fiscal rule with little political impact, by decoupling public investment from oil windfalls from international oil price fluctuations, as under this alternative rule public investment also depends on tax revenues. If Ecuador were to adopt this alternative fiscal rule, it would mitigate welfare losses due to oil price shocks and substantially reduce the volatility of the business cycle.

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Chapter 6

Voters versus lobbies: The political business cycle in Ecuador

This paper studies the political business cycle in Ecuador for the period 1900-2020. Empirical evidence reveals that the reelection of the incumbent is an infrequent and rare event in Ecuador. Additionally, a large fraction of elected presidents do not complete the four-year term. To explain this evidence, the paper develops an imperfect democracy political model with voters and interest groups. Each group supports the incumbent depending on the quantity of public resource they receive, which depend on how total resources are split between the two groups and on the business cycle. Whereas voters only decide every four years, interest groups have the power to depose the incumbent every period. The model predicts that the reelection of the incumbent is only possible in good economic times. We do not find any empirical evidence in favor of a political business cycle in Ecuador. This can be explained by the action of interest groups that greatly reduces the expected probability of reelection, except during exceptionally good economic times.

6.1 Introduction

In a democracy, elections are national events in which the electorate decides which candidate is elected and whether the incumbent is reelected or not. However, in some "weak" democracies interest groups exercise some degree of power that, to some extent, can counteract voters' decisions without necessarily interrupting democracy but exerting important consequences on the political cycle. This could well be the case in a democracy like Ecuador, where the political history during the twentieth century evidences the existence of multiple interruptions of the political term between elections forced by different interest groups, including the army. Gonzalez (2000) classifies some developing countries, particularly in Latin America, as imperfect democracies. She argues that while many developed democratic countries have enjoyed a stable political environment in the past 60 years, this is not the case for the "imperfect democracies" group which have experienced a number of political regime changes and turmoils. Indeed, Ecuador has been rated as a "flawed democracy" by the Economist Intelligence Unit (2019). This evidence raises important concerns about whether existing political business cycle models are adequate to be applied to "imperfect democracies" in the terminology of Gonzalez (2000).

This paper studies the political business cycle in Ecuador for the period from 1900 to 2020, adopting an "imperfect democracy" point of view. Three key characteristics are observed in the political system of Ecuador that support this novel view. First, the reelection of the incumbent president is a highly infrequent event in elections in Ecuador. Indeed, during the last 120 years only one incumbent, Rafael

Correa, has been (democratically) reelected. Second, only a small fraction of elected presidents have completed the constitutional mandate of four years in office. Third, even in the case, the incumbent remains in the seat during the four-year term, he is not a candidate to be reelected as he has no support from the voters, and hence, no chance to be reelected.

Based on that empirical evidence, the paper contributes by developing a stylized political economy model with voters and interest groups as a possible explanation for that evidence. Each group supports the incumbent depending on the quantity of public resources they receive. The amount of resources received depends on how total resources are split across groups and on the business cycle. While voters only decide every four years, interest groups have the power to depose the incumbent every period. The model predicts that the reelection of the incumbent is only possible in good economic times.

As highlighted by Drazen (2000), heterogeneity and conflict of interest are essential parts of political economy. The implications of interest groups have been studied by Kau *et al*. (1982), Grossman and Helpman (1996), and Drazen and Eslava (2010), all of them consider a heterogeneous society with different interests across groups of voters, stating that it is possible that incumbent politicians in developing countries transfer resources from one group to another in order to obtain electoral gains. Eslava (2010) reviews the literature on the political economy of fiscal deficits where groups of interest have been considered as one explanation for persistent fiscal deficits over the business cycle, and Talvi and Vegh (2005) consider that fight among the different interest groups for the common public resources as one of the causes that explain the procyclicality of fiscal policy in developing economies. As pointed out by Olson (1993) interest groups limit dynamic forces from the economy and the social system, depressing efficiency and reducing economic growth. Grossman and Helpman (1996) considered the role of interest groups but from a different perspective. They focus on interest groups' use of campaign contributions as an instrument for influencing public policy. Lohmann (1998) indicates that political decisions are often biased in favor of special interests at the expense of the general public, resulting in losses by the majority in excess of the gains by the minority. She argues that interest groups are better able to monitor incumbent activities and overcome the free-rider problem of costly monitoring, causing a policy biased in their favor. Balles, Matter and Stutzer (2022) show that US representatives are more likely to vote with special interests and against constituency interests the more special interest money they receive, especially during times of low media attention to politics.

In the literature, we find two large broad guidelines of the political business cycle theory: cycles generated by the government's economic intervention in the hope to be re-elected (opportunistic models) and the partisan view where the economic problems and policies are adopted in a different way, depending on the ideological orientation of incumbents' party. For the opportunistic model (Nordhaus, 1975), voters opt for the candidate who proposes the greatest benefit, analyzing the behavior of economic variables in the past, and the future proposal of the rulers in the case voters are rational. See, for instance, Cukierman and Meltzeer (1986), Rogoff (1987), Alesina and Sachs (1988), Rogoff and Sibert (1988), and Alesina (1988). On the other hand, the partisan model Hibbs (1977, 1987) proposes a differentiation of the behavior and expectations of the agents, where the existence of irrational or market-adapted expectations, and rational ones, continue to exist. See Dubois (2016) for a review of the literature.

However, these theoretical approaches are only valid for well-established democracies but cannot be directly applied to imperfect democracies where government

decisions are heavily conditioned by interest groups. In this paper, we depart from existing political business cycle models and expand the contributions previously made by considering a two agents model; lobbies and voters where the first have the power to overthrow the incumbent politician, while the latter has the power to put the politician in office and grant reelections.

This paper estimates a standard political business cycle equation using alternative specifications and controls. Contrary to previous literature, we do not find evidence of a political business cycle in Ecuador since little evidence was found that public spending or output is affected by the political cycle. This is consistent with the model presented in this paper, where the presence of interest groups and the absence of well-established political parties attenuate the use of fiscal policy as an opportunistic tool for increasing the probability of reelection. By contrast, most incumbents do not repeat as candidates for elections and therefore, they have no incentive to use fiscal policy to create a favorable climate for the upcoming elections.

We do not find any empirical evidence in favor of a political business cycle in Ecuador. This is explained by the action of interest groups that greatly reduces the expected probability to be re-elected, except for exceptionally good economic times.

The structure of the rest of the paper is as follows. Section 2 reviews some key features of the Ecuadorian political system. Section 3 develops the model where voters and lobbies interact politically, used to explain the Ecuadorian political instability. Section 4 describes the data used in the empirical analysis. Section 5 shows the main results regarding the political cycle in Ecuador. Finally, Section 6 collects the main conclusions.

6.2 A review of Ecuadorian main political features

6.2.1 Key political events

Ecuador is a republic since 1830, discontinued by some periods of dictatorships following both military and civil coups d'etat. During the first years of the republic, there was no universal suffrage and voting rights were conditioned by the voter's economic and social conditions. Only literate men, older than 25 years, and relatively higher income either from the trade or rental properties had the right to vote. Juan José Flores was the first constitutional president of Ecuador, declaring the separation of the State of Ecuador from the Gran Colombia, maintaining its original presidential government structure, which has remained without significant reforms to this day. Mainly, there has always been a multi-party political system with a unicameral representative with a President of the republic elected every four years. Historically, political parties have been loose organizations, mostly based on populist leaders, with little ground in governance programs or ideology.

Between 1830 and 1845, the office of president of the Republic was elected indirectly, that is, through the Legislative. The first presidents were mostly elected through Constituent Assemblies, a tradition in Ecuadorian politics that continued until 1867, with Otto Arosemena being the last constitutional president elected through a Constituent Assembly. This is one of the reasons why Ecuador has had 20 different Constitutions since its foundation, many of them created with the intention of legitimizing the government of a president. Since 1869, the president is elected by popular vote, being Francisco Robles the first president elected by direct vote. With the Liberal Revolution in 1895, the state was set to guarantee the secret, direct, equal, free, and universal form of elections. However, between 1906 and 1944, elections

were generally considered fraudulent or corrupt. The Constitution of 1946 introduced a series of changes aimed to modernize and make the election process more transparent, the reason why this year is considered to be the beginning of the real democracy in Ecuador.

In 1946 the position of Vice President was reinstalled, being elected separately from the president. The Vice Presidential position had been abolished in 1906 and became a substantial part of the Ecuadorian democracy ever since, being his main function to replace the president in case of dismissal or dead. However, this change in the structure of the government provoked a kind of "Iznogoud effect" (*I want to be Caliph instead of the Caliph*), where the incumbent president has been frequently deposed by power groups and replaced by the vice-president until the next elections. In 1968 the obligatory nature of the vote for men and women was established. After some periods of dictatorship, in 1978, with the return to democracy and the new Constitution, a series of new changes were introduced. Some of them were the optional voting for illiterate persons, the elimination of the senate and indirect voting, being replaced by a congress and direct voting, and the second round of elections for the election of the President and Vice President of the Republic. The president and vice-president are elected by direct suffrage on the same ballot, and the minimum voting age was set universally at 18 years old. Since 1998, a candidate who obtains more than 40% of the votes can also win, provided he/she has a difference of at least 10% over the second candidate. All these percentages are calculated on the total of valid votes (i.e., not counting null and blank votes). Finally, the Constitution of 2008 introduced facultative voting for 16 and 17-year-old people.

Ecuador's political history has been full of instability. Usually, power has been heavily concentrated on the figure of the president of the republic. This is explained by two facts. First, traditionally Ecuador's political culture has been characterized by "caudillismo", i.e., the excessive personalization of leadership. Second, political parties are weak, without solid political foundations, and organized around the figure of the candidate. This causes the life of political parties to be very short and linked to the political life of the candidate. Until 1947, most of the constitutional presidents of the republic came to power through coups d'état, exercising dictatorships that were tried to be legitimized through the drafting of new constitutions. As a consequence, the governance and stability of the presidents have usually been weak, which also explains why there have been many interim presidents. This high instability can be explained mainly due to the lack of party structures with defined ideologies and the people's expectancy around messiah politicians as a way of exercising politics, focusing mostly on demagogy. On the other hand, the high concentration of political power by the economic power has generated a permanent conflict between various actors involved in politics, Lobbies, and Voters. These factors combined with a weak economic structure translate into a frequent loss of popularity and approval of the presidents by mid-term, which unchained changes in the government plan, dismissals, etc.

6.2.2 Some preliminary empirical evidence

Table 1 shows some basic information about the political regimes in Ecuador. In 120 years of our time series, covering from 1900 to 2020, there has been only one consecutive reelection and two mandates of more than four consecutive years related to non-democratic elections. Two of those with Eloy Alfaro in what was known as the Liberal Revolution, one with Isidro Ayora in the Julian Revolution, and Rafael Correa in the present era in the Citizen Revolution. So, it is important to note that

large mandates are established by somewhat meaningful events in history. As so, re-election is a very rare event in Ecuador.

It is also important to highlight that over a total of 34 presidents just 16 presidents have managed to complete or extend their term and 18 did not end of the 4th year –16 were ousted, 9 being overthrown by coups d' etat being replaced by the vice president on 4 occasions and in the remaining situations power was held by military dictatorships, another person was put in charge or new elections were summoned. The remaining 2 died in office–.

The average president's time in office is 37.2 months, i.e., presidents have been in office for a little more than 3 years. An extraordinary example of this instability is the case of Dr. José María Velasco Ibarra , who is the longest-serving president, having been president for a total of 46 months and elected President 5 times (1934, 1944, 1952, 1960 and 1968) but only finishing 2 mandates. Also worth mentioning is the political turmoil seen from 1996 to 2005, when the country had 6 presidents, three of them overthrown (Bucaram, Mahuad and Gutierrez) due to popular rejection but also due to the interests of power groups opposed to the government, indigenous revolts, insurrections by the military, among other cases. In two occasions being replaced by the vice-president and in one by an interim president. In the contemporary history of the country there were two military dictatorships in the country, between 1963 and 1966; and between 1972 and 1979, when democracy returned with the election of Jaime Roldós. The only exception in our current timeline is the case of the president Rafael Correa from 2007 to 2017, winner of the in 2006 elections and reaching 10 years and 4 months of government, winning two re-elections in 2009 and 2013. Ending his term with an over 60% approval rating, an unprecedented case for the country. The government of Rafael Correa has been the most stable in national history. Correa was followed in charge by his former vice president Lenin Moreno.

Considering all these features of the country, the Partisan model detailed in the prior chapter does not apply properly in Ecuador. The reasons are the following: First, re-election in Ecuador is complex due to the erosion of the political capital of the politicians, especially since the moment they are elected and also because of lack of party structures and clear ideologies. Second, the presidents do not complete their term of office because of the existence of many different interest groups in the country pressuring the elected presidents into making decisions against its popularity to favor its own interests. Third, there is not a political business cycle due to the extreme difficulty of achieving a reelection. It would be more accurate to link the succeed of certain politicians with the commodities prices of the main products Ecuador produces and the international business cycle.

Descriptive statistics for the president variable used in our empirical analysis are presented in Table 1.

Table 1: Key characteristics of political regime in Ecuador	
Presidents with 4 or more years in office	16
Presidents with less than 4 years in office	18
Presidents ousted	16
Substitution by vice-president	4
Incumbent candidate reelected	1
Coups d'etat	9
Average duration (months)	37.2
Standard deviation duration (months)	22.68
Minimum duration (months)	10
Maximum duration (months)	125
Source: Georgetown University's Political Database of the Americas	

To complement the information provided by Table 1, Figure 1 plots the survival probability using the months in charge using the Kaplan-Meier survival model estimator (Kaplan and Meier, 1958). The survival curve states the probability of a president staying in office and shows clearly that in the period analyzed the presidents have less than 50% chance to finish their mandate. It is also notable the sudden drop just after the 48th month, indicating that the probability of being reelected is less than 10%. These results are indicative of the particular features of politics in Ecuador. Only three presidents were in office for more than 48 months, Eloy Alfaro, Isidro Ayora, and Rafael Correa. However, only the last was reelected while the two first were non-reelected interim presidents.

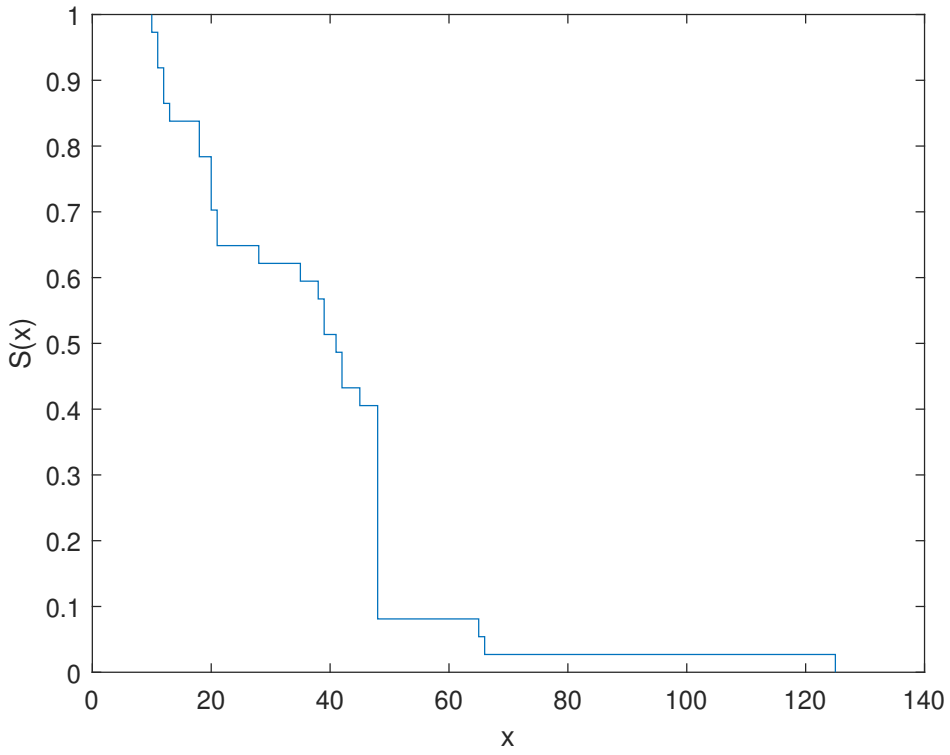

Figure 1: Kaplan-Meier survival estimate curve for the time in office. S(x) denotes the survival estimate and x denotes the duration in months.

Based on this preliminary evidence, we can identify three key particular characteristics of the political behavior of Ecuador: i) Extremely low (close to zero) probability of re-election by the incumbent, ii) only a relatively low fraction of incumbents have completed the political term, and iii) the rare re-election events have taken place in a period of high GDP growth. Traditional political business cycle models developed in the literature, neither the opportunistic model, nor the partisan model are able to explain the political dynamics in imperfect democracies.

Brander and Drazen (2008) estimate the probability of reelection. Fair (1978) and Alesina and Rosenthat (1995) found a significant effect of growth on reelection in the US. However, that effect was found to be generally no significant for other developed countries. By contrast, in developing countries GDP growth is a significant variable.

6.3 The model

Based on previous evidence, this section develops a simple model to account for the main observed characteristics of the political system in Ecuador. In particular, we will ask the model why it is so difficult for an incumbent president to be reelected or why a relatively high number of presidents are forced to leave the seat before the end of the term. For that, we consider a political system representing an "imperfect" democracy along the lines of Gonzalez (2000) or a "flawed" democracy as Ecuador is defined by the Economist Intelligence Unit (2019). Like in many other developing countries that can also be classified as imperfect democracies, a key characteristic of these political regimes is the presence of some interest groups that, even if they cannot influence the direct votes in regular elections, have the power under some circumstances to influence policies of the incumbent and even the duration of the term of the incumbent. Therefore, both the duration of the incumbent in office and the probability of reelection will be determined by the interplay between voters and interest groups.

We assume that two types of agents are part of the political system: voters, V, and interest groups (lobbies), L. We consider a political regime in which the president is elected by the voters in regular democratic elections. We assume that, as in standard political models, the objective of the elected president is to remain in power and be reelected in future elections. However, between elections, political decisions are significantly influenced by interest groups. Furthermore, we consider that the power of interest groups can be high enough to alter the legally established term of office of the president. This is the "imperfect" characteristic of democracy where interest groups cannot influence the results of elections but they can limit the duration of the office of the elected in case they are not satisfied with policy decisions. This introduces a different timing for the two groups in choosing who seat at the presidency of the government. Whereas voters only decide in the elections to be celebrated say every four years, lobbies influence the government every period. Interest groups have some privileges that imply the appropriation of some rent and they have the power to overturn the government at any period if they are not satisfied with the government policy.

The problem to be solved by the newly elected president once elections have been celebrated is to maximize the number of years in office, T,

$$\max \quad T = \min(T_V, T_L) \tag{6.1}$$

where T_V is the number of elections that voters support the incumbent president, where $T_V = (k, 2k, 3k, ...)$, and where $k = 4$ is the duration of the term in years (the interval in years between elections), and T_L is the number of years the lobbies support the incumbent $(T_L = 1, 2, 3, ...)$. The number of years in office, T is the minimum value of T_V and T_L. Both the duration in the office of the incumbent and the probability of reelection depend on the support of the two groups. With the support of the two groups of agents, it is assumed that the president remains in office for the four-year term and is reelected in successive elections. With the support of interest groups but not of voters, the incumbent remains in office for the whole term but is not reelected. With the support of voters but not the interest groups, the incumbent is deposed at the end of the period (year).

Support by voters and interest groups depends on how a country's resources are distributed between them and on the total quantity of resources of the country, which is exogenously determined by the international business cycle. The president decides how the budget for each year is distributed between the lobbies and the voters. It is expected that resources diverted to interest groups do not contribute to economic growth or to social welfare. We assume that in a given year the budget is G_t, to be split between voters and interest groups,

$$G_t = G_{V,t} + G_{L,t} \tag{6.2}$$

The total quantity of resources is a function of the macroeconomic conditions over the business cycle and can vary from period to period. In good economic times, G_t will take a high value, whereas in bad economic times, G_t will take a low value. We assume that $T_L = \infty$, and $T_V = 4$ if all resources are granted to interest groups, i.e., $G_{L,t} = G_t$. In this scenario, $T = 4$, and the president finish the term in office but is not reelected. By contrast, if all resources are granted to voters, $G_{V,t} = G_t$, then we have that $T_V = \infty$, and $T_L = 1$, and the government is overthrown at the end of the period. However, it is assumed that whereas $G_{V,t} = G_t$ and $G_{L,t} = 0$ is a possible outcome, $G_{L,t} = G_t$ and $G_{V,t} = 0$ is not possible, as a minimum level of funds must be spent in the economy.

The utility of each group is a function of received funds, $U^V(G_{V,t})$ and $U^L(G_{L,t})$. The objective of the president is not to maximize social welfare as a weighted sum of the utilities of the two groups, but to allocate funds to each group in order to maximize the number of years in office. Support from each group to the incumbent president depends on utility compared to a minimum threshold. If the utility of a particular group is higher than its minimum utility, that group supports the government. How the utility of each group results compared to the minimum threshold depends on the total resources available for spending. When a large amount of resources are available (good economic times with high growth), both groups can be satisfied. However, in bad economic times, available resources decline, being difficult to satisfy both groups simultaneously. As it had been stated by Kalecki (1943) the mechanism that underlies the conflict between political behavior and economic growth is the conflict of interests between individuals.

In our political model, time can take three values: 1, 4, or ∞. A value of 1 means that the president is not supported by the interest group and hence, will remain only one more period in office. A value of ∞ means that both groups support the incumbent and once the term is finished, the incumbent is reelected. In the case the incumbent is supported by the lobbies but not by the voters, we assign a value of $T = 4$, indicating that the incumbent will remain in office for the whole term but no reelection occurs. Each group supports the incumbent if and only if its utility

is above the minimum threshold (U^V_{min}, U^L_{min}). Figure 2 plots the combination of utilities of the two groups compared to the minimum utility of each group to support the president. When the utility of the two groups is higher than their minimum, both groups support the president, $T_V = T_L = \infty$. In the case in which the utility of voters is higher than the minimum and the utility of lobbyists is lower than the minimum, the president is supported by the voters but not by the lobbyists, and then $T_V = \infty$ and $T_L = 1$. In the case in which the utility of the voters is lower than the minimum but the utility of lobbyists is higher than the minimum, the president is only supported by the lobbyists and then $T_V = 4$ and $T_L = \infty$. Finally, if the utility for the two groups is lower than the minimum threshold nobody supports the president and then $T_V = 4$, $T_L = 1$.

	$U^V > U^V_{min}$	$U^V < U^V_{min}$
$U^L > U^L_{min}$	$T_V = T_L = \infty$	$T_V = \infty$ $T_L = 1$
$U^L < U^L_{min}$	$T_V = 4$ $T_L = \infty$	$T_V = 4$ $T_L = 1$

Figure 2: Political regime outcomes, voters versus lobbies.

The utility of each group is assumed to be defined by the following functional form,

$$U^i = G^{\theta}_{i,t} \tag{6.3}$$

where the parameter θ takes a positive value lower than one ($0 < \theta < 1$). That is, we assume decreasing marginal utility of each group as a function of resources. We assume that the minimum utility threshold, $U^i_{min}(G_{i,min})$ for $i = V, L$ is a fixed number. The economic situation driving the total amount of resources is represented by the relative position of the dot inside the box. As the dot moves up and right, this represents a worsening in economic conditions which is equivalent to a rise in the relative minimum threshold. As the dot moves down and left, this is an improvement in economic conditions or a decline in the relative minimum threshold. So, an increase in available resources is equivalent to a decline in the relative minimum threshold defined as:

$$u^i_{min} = \frac{U^i_{min}(G_{i,min})}{U^i_{max}(G_{i,max})} \tag{6.4}$$

where $G_{i,min}$ is a constant value of resources to group i, and where $G_{i,max}$ is a variable maximum value of funds received by group i, which depends on economic conditions. In good times, available resource increases, reducing the relative minimum

threshold for the two groups, increasing the area for scenario (c). However, in bad times the relative minimum threshold increases, increasing the area for scenario (b). The relative utility for each group is defined as,

$$u^i = \frac{U^i(G_i)}{U^i_{max}(G_{i,max})} \tag{6.5}$$

which takes a value of 1 when all resources are granted to group i.

To keep things simple, it is assumed that the probability of reelection, p, is

$$\left\{ \begin{array}{llll} p = 1 & if & u^V \geq u^V_{min} \\ p = 0 & if & u^V < u^V_{min} \end{array} \right\} \tag{6.6}$$

Similarly, the probability of remaining in the seat one more period between elections, q, is,

$$\left\{ \begin{array}{llll} q = 1 & if & u^L \geq u^L_{min} \\ q = 0 & if & u^L < u^L_{min} \end{array} \right\} \tag{6.7}$$

A probability of $q = 0$ leads to a scenario where the incumbent is dismissed at the end of the period (scenario denoted by 1), independently whether $p = 1$ or $p = 0$. A probability of $q = 1$ and $p = 0$ lead to a scenario where the incumbent has to leave the seat after the four-years term (scenario denoted by 4) as the probability of reelection is zero. Finally, if probabilities are $q = 1$ and $p = 1$, this represents the scenario of reelection denoted by an infinity.

Once elected, the incumbent faces three alternative scenarios depending on both how resources are distributed and the quantity of available resources:

Scenario (a): Lobbies receive more utility than their minimum level but at the cost of taking funds away from the economy, which implies that the utility of voters is below the minimum threshold. The probability of reelection in the next elections is null but the incumbent remains in office during the four years between elections as is supported by the interest groups. In this scenario, the president will remain in the seat during the entire mandate until the next elections but with no chance to be reelected. So a different president will be elected. We denote this scenario with a value of $T = 4$ (the duration of a mandate).

Scenario (b): Lobbies receive less utility than their minimum level. Two possibilities emerge in this scenario. First, voters receive more utility than their minimum threshold but at the cost of reducing lobbies' utility below the minimum value. The president is ousted, and according to the Constitution, the vice-president becomes the new president. The incumbent president would gain the next election and be reelected given the support of voters, but he/she is deposed before reaching the fixed date for the new elections. A second possibility exits; voters receive less utility than their minimum. In this last case, even voters do not support the incumbent. However, this lack of support by voters does not matter, given that the incumbent has no possibility of being reelected in any case. This scenario is denoted with a value of $T = 1$, as the incumbent will be deposed at the end of the period.

Scenario (c): Both voters and lobbies receive more utility than the minimum and hence both groups support the president. The incumbent remains in the seat and in case of new elections he/she becomes reelected. We denote this scenario with a value of ∞.

Figure 3 plots all three scenarios for a given relative minimum value of the utility of the two groups which identifies the three possible scenarios.

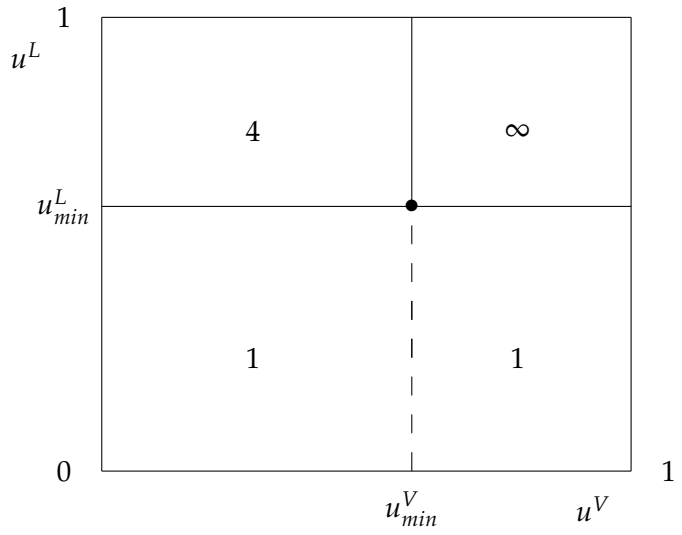

Figure 3: The three scenarios. (1) indicates a combination of relative utilities such as the president will remain in seat only one year. (4) indicates the combination of relative utilities for which the president will remain in office during all the term until next elections without the possibility of being reelected. (∞) indicates de combinations of relative utilities for which the president will remains in office forever as he/she will be reelected in future elections.

Figure 4 represents scenario (a) and the combination of utilities for each group. The point in the figure represents the combination of minimum relative utility for the two groups, whereas the curve represents the combinations of relative utilities that can be reached depending on how resources are distributed between the two groups. Notice that the curve representing relative utilities is concave given that $0 < \theta < 1$, restricted to $0 < G_{V,t} \leq G_t$ and $0 \leq G_{L,t} < G_t$. As it can be observed, in this scenario the point representing minimum relative utilities is above the relative utility curves, indicating that there are not enough funds to satisfy both groups simultaneously. This could reflect bad economic times or insufficient economic growth. There is a section of the curve for which $u^L > u^L_{\text{min}}$ but $u^V < u^V_{\text{min}}$. There is another section of the curve for which $u^L < u^L_{\text{min}}$ and $u^V < u^V_{\text{min}}$. And finally, it is another section of the curve for which $u^V > u^V_{\text{min}}$ but $u^L < u^L_{\text{min}}$. The last two cases led to the president being ousted in one period as there is no support from the lobbies, whereas in the first case the president would remain in office until the next elections but with no chance to be reelected. In this scenario, the optimal strategy for the incumbent is to satisfy the demand for resources by the interest groups, choosing a point in the upper section of the utility curve (the thick line). Looking at the data, this scenario seems to be highly common in Ecuador.

Figure 5 plots scenario (b). In this scenario funds are very limited due to bad economic situations or equivalently relative minimum utility demanded by the two

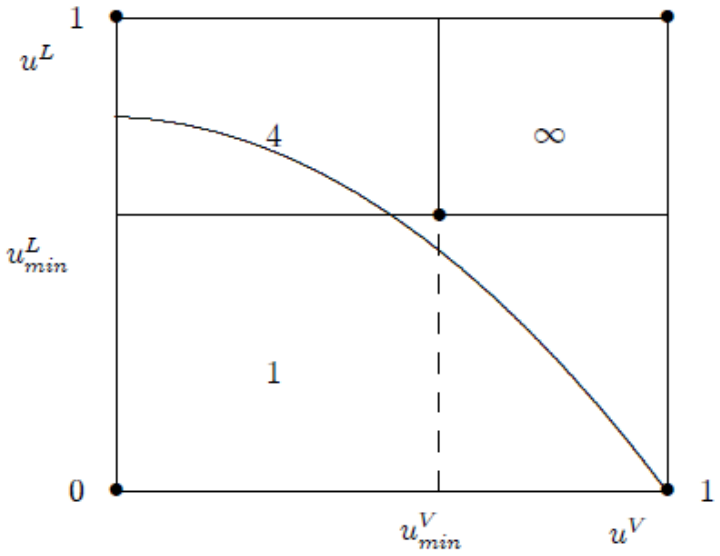

FIGURE 6.1: Scenario (a): Not enough resources to satisfy both groups simultaneously

groups is very high. In this scenario, it is impossible to satisfy the funding demand by the lobbies, and there are only two alternatives for the incumbent: allocating resources such as $u^L < u^L_{\text{min}}$ and $u^V < u^V_{\text{min}}$, or allocating resources such as $u^L < u^L_{\text{min}}$ and $u^V > u^V_{\text{min}}$. In any case, the president is deposed in one period. The incumbent can choose a distribution to satisfy voters' preferences, but their support does not have any effect on the time in office. This would reflect a situation with low economic growth resulting in low total resources. Given that it is assumed a minimum limit for the amount of resources granted to voters, even when the distribution of resources is such that only that minimum is granted to voters, the remaining resources are not enough to satisfy the minimum amount required by the interest groups.

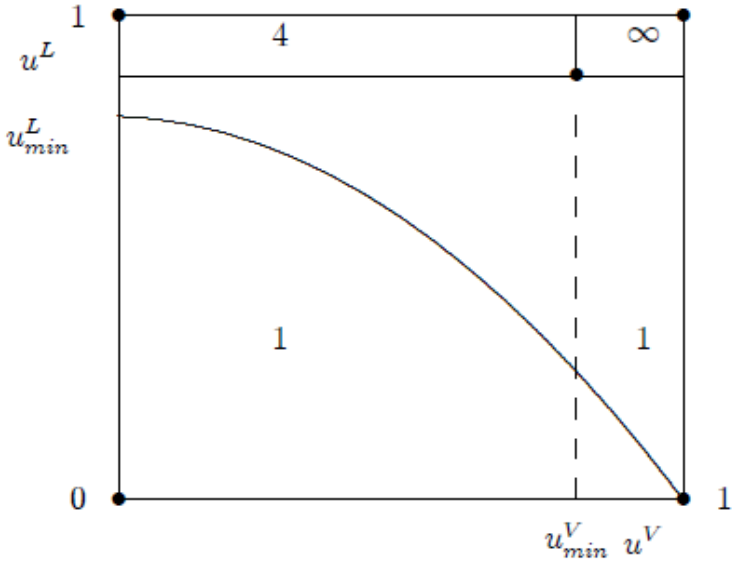

FIGURE 6.2: Scenario (b): Not enough resources to satisfy interest groups

Finally, Figure 6 plots scenario (c). This is the most favorable scenario for the incumbent and it would correspond to good economic times with high growth. In this case, the availability of funds is enough to satisfy both groups as the point representing the relative minimum utility is below the curve representing the relative utilities that can be reached. There is a section of the curve for which $u^L > u^L_{\min}$ and $u^V > u^V_{\min}$, so the two groups are happy with the incumbent president policy and hence, the president can finish the term in office and once new elections take place, he/she will be reelected. Empirical evidence for Ecuador for the last 120 years reveals that this is a rare event. Indeed, only one incumbent has been reelected once the four years mandate has finished.

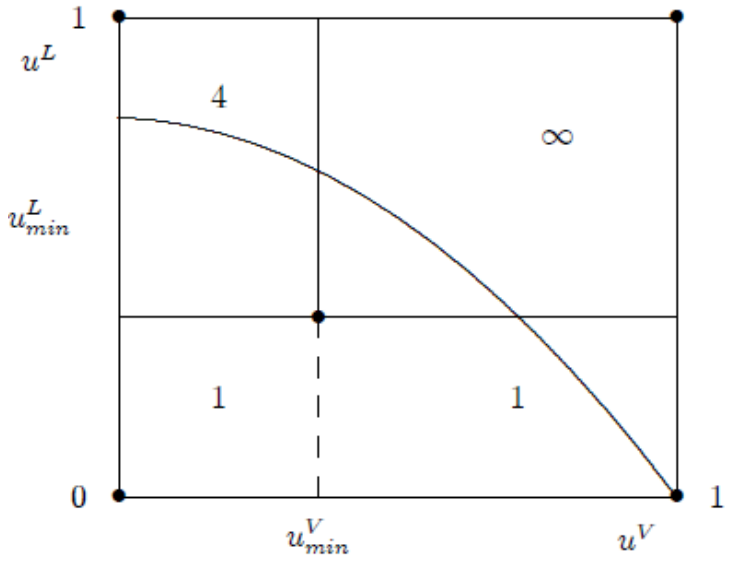

FIGURE 6.3: Scenario (c). Enough results to satisfy both groups.

Summing up, the incumbent is tempted to satisfy demands by interest groups, and only in case of resources are large enough, also voters' demands are satisfied. The model produces a number of predictions. First, the probability of being reelected is only positive in good economic times. Second, in normal economic times where resources are not enough to satisfy both groups, policy decisions by the incumbent will favor the interest groups,

6.3.1 Extending the model: The power of civil society

The model highlighted above has been built using some probably too restrictive assumptions for the sake of simplicity. In particular, the model assumes that voters (the civil society) have no power to counteract interest groups between elections. This implies that in any situation in which lobbies are not satisfied the incumbent president is deposed independently on the support of the civil society. This could be the case in Ecuador, a country in which political parties are weak and the standard division left-right is not well defined. However, the power of civil society can reduce

the power of lobbies to depose the incumbent president. Indeed, some revolts of the civil society in Ecuador have forced some interest groups to intervene, even arriving in a conflict between the army and the police.

Here we extend the basic framework by introducing some civil society power that can counteract interest groups' power. This possibility is illustrated in Figure 7. For simplicity, we assume a linear combination of the relative powers of the two groups. Again, we have four outcomes, with the difference that when the support to the incumbent president by the civil society is high enough the lobbies cannot overturn the government. The scenario in which $u^V > u^V_{\text{min}}$ and $u^L < u^L_{\text{min}}$, is now split in two areas. When the relative utility of voters is very high and the relative utility of lobbies is not too low, civil society heavily supports the incumbent president and it can counteract any attempt by lobbies to depose the incumbent president. However, if the relative utility of voters is not high enough and the relative utility of lobbies is low enough, the support of the incumbent president by the civil society is not sufficient to prevent the lobbies from removing the incumbent president. In other words, as voters receive more resources, it is more likely that they will be willing to support the president against lobbies.

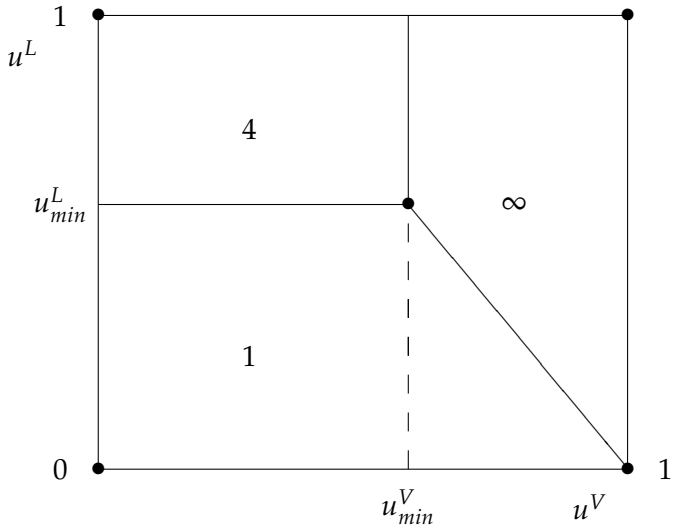

Figure 7: The three scenarios with civil society power.

Predictions from the model can be directly compared with the data. Table 2 shows the GDP growth rate predicted by the model for each scenario and the data for each observed scenario. According to the model, re-election events should be related to high economic growth, a full-mandate but no re-election would be related to a medium growth rate and an unfinished term would be related to a low GDP growth rate. Average observed growth rates are consistent with the expected ones for all three scenarios.

Table 2: Model Prediction versus data*

	GDPpc growth	
Event	Prediction of the model	Data (% growth)
Full mandate and no re-election	High growth rate. Scenario (a)	1.77
Less than 4 years	Medium growth rate. Scenario (b)	1.26
Re-election	Low growth rate.Scenario (c)	3.40

* Excluded military dictatorships

6.4 The political business cycle in Ecuador: Empirical evidence

This section empirically studies the political business cycle in Ecuador. A number of papers have estimated the relationship between the opportunistic political cycle and the behavior of the GDP or fiscal indicators since it is indicated that the rulers tend to carry out economic policies aimed at greater popular acceptance, but these measures lead to positive or negative variations in the GDP as a sequence. Among them, Alesina and Roubini (1992) study OECD countries and find that almost all the countries can be described by the opportunistic cycle model. Shuknecht (1996) indicated that macroeconomic variables are affected by the opportunistic political cycle and that GDP in countries decreases due to fiscal policies aimed at the political promotion of the rulers. Alesina, Roubini and Cohen (1997) assert that one year before the elections, GDP begins to increase, and unemployment decreases; during the electoral period the behavior of the economic growth variable is maintained. However, one year after the election, national income tends to decrease. Drazen (2001) used a time series of 25 years and stated that GDP increases due to a monetary policy induced by the electoral political cycle, since it is the most agile mechanism for the increase of income, prior to the electoral process.

Most of the empirical literature has been focused on developed countries and less on developing countries. Empirical evidence shows that the political cycle in economic activity is an issue specific to developing countries (Alesina *et al.*, 1997). There are a number of authors who have analyzed in more depth the political business cycle for developing countries though. In essence, this phenomenon can occur in countries with different economic situations as argued by Schuknecht (2000) and de Haan and Klomp (2013).

Kraemer (1997) investigates the impact of fiscal policy and business cycles in 21 countries of Latin America and the Caribbean, revealing the fact that the budget deficit is higher and unpredictable in the election years than in other periods. Schuknecht (1996, 1998) study the impact of electoral cycles on the exchange rate in 25 developing countries. He found strong evidence for the existence of fiscal policies in countries that had a fixed exchange rate and foreign exchange reserves are sufficient. The author argued that the flexibility of the exchange rate before elections reduces the desire of Governments to engage in expansionary fiscal policies. Such measures would produce inflation and will affect the image of the government. In countries with a fixed exchange rate, Governments have the interest to adopt an opportunistic fiscal behavior before the election to ensure a new mandate. Magaloni (2000) demonstrates the existence of opportunistic behavior in Mexico between 1965 and 1985. Gonzalez (2000) analyzed the influence of the level of democracy in the political budget cycle. The difference between developed countries and developing countries has been analyzed by Shi and Svensson (2006). They used large panel

data, covering 123 countries over a period of 21 years to analyze the relationship between electoral cycles and politics. The authors used the following arguments: before elections, regardless of whether revenues decrease, the government increases their spending in order to increase the chance of being re-elected, which triggers an increase in the budget deficit in the election years. They also highlighted some important differences between the developed countries and the developing ones, regarding the composition and size of the political business cycle. The elections induced in the developing countries a budget deficit as a percentage of GDP almost double compared to the developed countries: on the eve of the election, the developed countries recorded an increase in the average budget deficit by roughly 0.6 percent on average, where in developing countries the average percentage was around 1.3%.

6.4.1 Data

Our empirical strategy relies on the compilation of data from different sources into a new data set in order to verify or deny the existence of a political business cycle in Ecuador. This section describes in detail how these data were compiled, prepared, and used in our model. The data samples include the dependent, electoral, and control variables. We use different sample periods depending on data availability.

In particular, we test whether GDP or public spending is affected by elections. The explanatory variable used was the real GDP per capita extracted from the Maddison Project Database. This variable will mainly show us if the economic activity is in fact arise during electoral processes. To construct our yearly presidential set we used a database of annual observations with the Presidents of Ecuador. Our main source of data was the Political Database of the Americas created by Georgetown University. The data samples used cover 1900–2020.

To reflect the conditions on which increases in GDPpc are conducted we used dummy variables to indicate the years the president was in office. These binary variables were classified as D0, D1, and D2. Where D0 is the last year of the presidency or the year in which elections were conducted, D1 and D2 correspond to the year prior to the elections and two years prior to the elections, respectively.

In order to establish the economic and political conditions of the country and to identify if the incumbent politician is in fact adjusting the monetary and fiscal policies to favor their electoral purposes we used the following control variables for the model:

a) Inflation. The variation experimented by the country compilated by us from different sources mainly the Maddison Project Database. The data samples used covers 1900–2020.

b) The Democracy Index. By considering the political stability and democratic conditions, this variable is useful to us to explain the changes experimented in Ecuador between different political processes. This variable was obtained as a result of combining the autocracy and regulation of participation index in a scale from 0 to 10, being 0 the most democratic result possible and 10 a totalitarian dictatorship. Its data were extracted from the Polity III database created by Jaggers and Gurr (2019). The data sample used covers 1900–2020.

c) Ecuadorian main commodity exports. Accounted as the Free On Board exports of oil, banana, coffee and cacao. Historically, these products have been a keystone in the Ecuadorian international trade representing in average 13,42% of the GDP in the period analyzed, according to data from the Ecuadorian Central Bank . Due to data restrictions, the data sample used covers 1950-2020.

d) Public Spending has been taken from the Central Bank of Ecuador, covering the period 1950-2020. e) Public Investment. Extracted from the IMF Investment and Capital Stock Dataset, with methodology developed by Gupta, S., et al., (2014). Due to data restrictions, the data sample covers 1960-2020.Preliminary analysis of the data reveals no evidence in favor of Political Business Cycle. On this line, figure 2 presents the average growth rate of GDP per capita, inflation, public spending, revenues from exports of main commodities and public investment classified according to the year of office. Corresponding the year 1 to the first year were the president was elected and year 4 the year before elections. As we can see, there are no enough proof of an opportunistic behavior in Ecuador. This results are aligned with those of many studies for OECD countries, for instance, Alesina, Roubini and Cohen (1997).

6.4.2 Duration in office

As a first step, we extend the previous analysis of the duration in the office. Non-parametric estimation of the survival function presented in Figure 1 showed that about half of the incumbents did not finish the four years constitutional mandate and that only one was reelected. Here, we use the Cox proportional hazards regression method. For table 3 we run a regression using the months in office as the dependent variable and GDPpc growth rate at the end of each mandate, inflation, and the democracy index as control variables. The results show how statistically significant is for Ecuador the correlation between economic growth and the chances the incumbent has to retain power. These results are in line with the ones obtained by Brender and Drazen (2008), who argued that in developing countries, increases in economic activity are the main source of information for voters. It is also worth noting that both inflation and the democratic index are less relevant.

Table 3. Duration in office (1900-2020)

	(1)	(2)	(3)
Constant	25.4245	23.3713	32.6562
	(6.4512)	(4.7826)	(3.3529)
GDPpc growth rate	1.9144	1.9798	2.1028
	(4.4957)	(4.5170)	(4.6625)
Inflation		0.1368	0.0200
		(0.7200)	(0.0922)
Democracy Index			-1.8014
			(-1.1009)
Adjusted R-squared	0.35	0.34	0.34

Note: t-statistics in parenthesis.

6.4.3 The Ecuadorian Political Business Cycle

In the vast literature, there have been many econometric tests for the opportunistic PBC. The most common form of these models in terms of outcomes is to run an autoregression of an economic performance measure on itself, a small set of control variables, and political dummies to test a specific theory. Based on our theoretical framework, the basic empirical specification for our econometric model is as follows:

$$y_t = \alpha + \sum_{i=0}^{2} \beta_i d_{i,t} + \sum_j \gamma_j x_{j,t} + \varepsilon_t, \tag{6.8}$$

where $d_{i,t}$ is the dummies election variables, and $x_{j,t}$ are the control variables. The dependent variable is where the equation shows the relation between $Y_{i,t}$ (GDPpc growth rate), the constant α_t, the $\sum_e^n$ (election variables), the $\sum_c^n$ (control variables), and the error $\varepsilon_{i,t}$.

The empirical results for the regressions regarding the GDP per capita are displayed in Tables 4 and 5. It is worth mentioning that the regressions shown in tables 4 to 7 were also conducted using the growth rates instead of the level values for all variables. The results, however, remained almost invariable.

Table 4 shows the OLS regression results for the specifications in a time series from 1900 to 2020. These range goes from the simplest one with D0 dummy term in column (1) to the most complete specification that includes the three dummies plus the control variables in column (5). The regressions reveal weak correlations between the real GDPpc with all the election variables. This may be seen as evidence of the no existence of an political business cycle in Ecuador. In other words, the politicians do not seem to be using fiscal policy in electoral years. It also important to note that Ecuador is since 1999 by law a dollarized economy which implies less possibilities of implementing opportunistic monetary policies usually used by politicians.

We can also notice how inflation is related in a direct way to increases in GDP while the democracy index is related inversily to GDP which in our case means that democatic institutions in fact favor economic growth. Finally, when a lagged GDPpc growth rate was includded in the regression the results showed a weak correlation, which is very indicative of a volatile business cycle in Ecuador.

Table 4. Real GDP per capita (1900-2020)

	(1)	(2)	(3)	(4)	(5)
Constant	8.1448	8.1144	8.0724	7.9277	8.9211
	(110.8671)	(88.6805)	(63.7398)	(60.2738)	(50.5212)
D0	0.1325	0.1629	0.2050	0.2166	0.2484
	(0.8983)	(1.0339)	(1.1349)	(1.2399)	(1.7035)
D1		0.0865	0.1285	0.1626	0.1708
		(0.5604)	(0.7230)	(0.9444)	(1.1884)
D2			0.0885	0.1279	0.1425
			(0.4815)	(0.7175)	(0.9578)
Inflation				0.0101	0.0017
				(3.0174)	(0.5724)
Demmocracy Index					-0.1855
					(-7.1819)
Adjusted R-squared	-0.0016	-0.0074	-0.0140	0.0517	0.3396

Note: t-statistics in parenthesis.

Table 5 shows the OLS regression results for the specifications in a time series from 1960 to 2020. These range goes from the simplest one with the D0 dummy term in column (1) to the most complex specification that includes the three dummies plus the control variables, including the commodity exports and the public investment in column (8). The regressions results indicate no relation between the GDPpc and the dummies analyzed. Thus, corroborating the results from table 4 and so indicating the no existence of a Political Business Cycle. On the other hand, the results reveal a strong linkage between GDPpc and the commodity exports establishing this as the main explicative component for the increase in GDPpc. This table solidifies the statement that Ecuador lacks a political business cycle, having instead a business

cycle strongly driven by external prices of its main commodities. Thus, transferring the external commodity prices volatility to the GDP. Finally, when a lagged GDPpc growth rate was included in our analysis the results showed a weak correlation, which is very indicative of a volatile business cycle in Ecuador.

Table 5. Real GDP per capita (1960-2020)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	8.693	8.702	8.765	8.710	9.063	5.712	4.103	4.739
	(160.7)	(124.7)	(84.11)	(77.18)	(71.21)	(77.47)	(10.80)	(12.59)
D0	0.005	-0.004	-0.067	-0.054	0.014	0.005	0.009	0.012
	(0.053)	(-0.034)	(-0.491)	(-0.401)	(0.117)	(0.267)	(0.509)	(0.819)
D1		-0.023	-0.086	-0.072	-0.018	-0.001	0.001	0.008
		(-0.210)	(-0.636)	(-0.533)	(-0.154)	(-0.049)	(0.029)	(0.506)
D2			-0.115	-0.105	-0.046	0.001	0.005	0.005
			(-0.815)	(-0.748)	(-0.372)	(0.059)	(0.296)	(0.345)
Inflation				0.003	-0.001	-0.001	-0.002	0.000
				(1.242)	(-0.508)	(-1.814)	(-4.429)	(-1.156)
Demmocracy Index					-0.082	0.013	0.007	0.000
					(-4.449)	(3.460)	(2.137)	(-0.014)
Commodity Exports						0.211	0.169	0.119
						(47.48)	(15.77)	(10.91)
Public Spending							0.097	0.046
							(4.295)	(2.262)
Public Investment								0.148
								(7.328)
Adjusted R2	-0.014	-0.029	-0.034	-0.025	0.202	0.978	0.982	0.985

Note: Estadistic t between ()

Based on the tables analized, we are able to clarify some important questions about the Ecuadorian economy:

1) The volatility of the Ecuadorian Business Cycle, due to the importance of the comodity prices, and

2) The lack of correlation between GDPpc to the election variables we analized, indicating there is no existence of a Political Business Cycle.

6.4.4 Public spending and investment changes

In order to develop our analysis further we measured the relevance of the commodities for the Ecuadorian economy. For this, we run the OLS regressions for the public spending. The results are reported in Table 6. Is worth noting that, as we mentioned in the afore subsection, the economic activity is strongly linked to the commodities exports and that the consecuential GDP growth is traslated into public spending. It is important to note that for this table we use a commodity exports lagged -1, this allows us to quantify the correlation between the commodity exports of the year t-1 and its effect on the current year.

Table 6. Public Spending (1950-2020)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	23.0861	23.1139	23.2847	22.9069	23.5206	16.5960	6.4695
	(183.1032)	(141.9648)	(96.0413)	(96.3643)	(83.7757)	(48.9740)	(2.0850)
D0	-0.0255	-0.0533	-0.2241	-0.1393	-0.0202	-0.0684	-0.0528
	(-0.1075)	(-0.2050)	(-0.7090)	(-0.4875)	(-0.0757)	(-0.7273)	(-0.6017)
D1		-0.0708	-0.2416	-0.1458	-0.0520	-0.0391	-0.0174
		(-0.2724)	(-0.7644)	(-0.5098)	(-0.1957)	(-0.4170)	(-0.1985)
D2			-0.3115	-0.2448	-0.1428	-0.0407	-0.0447
			(-0.9514)	(-0.8278)	(-0.5196)	(-0.4183)	(-0.4942)
Inflation				0.0200	0.0129	0.0142	0.0151
				(4.0485)	(2.5921)	(8.0437)	(9.0794)
Demmocracy Index					-0.1430	0.0621	0.0346
					(-3.5087)	(3.5877)	(1.9013)
Commodity Exports						0.4371	0.0704
						(21.3702)	(0.6205)
GDPpc							1.7585
							(3.2806)
Adjusted R-squared	-0.0143	-0.0281	-0.0296	0.1628	0.2853	0.9108	0.9226

Note: t-statistics in parenthesis.

For the Table 7, we run the OLS regressions for public investment. Its results mainly show that the election variables are indeed not connected to the public investment. It is often considered in the literature that the public investment is a very relevant variable to confirm the existence of a political business cycle since its results in the economy and society are in general visible to the electors. Thus, it would be in the incumbent's benefit to increase it in electoral years. This results confirm the statement of the lack of Political Business Cycle in Ecuador. It is important to note that for this table we use a commodity exports lagged -1, this allows us to quantify the correlation between the commodities exports of the year t-1 and its effect on the current year.

Table 7. Public Investment (1960-2020)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	8.4691	8.5195	8.6700	8.8055	9.3680	2.5258	-11.9368
	(81.9635)	(64.0190)	(45.2135)	(41.5646)	(42.0638)	(5.6657)	(-3.8687)
D0	-0.0831	-0.1335	-0.2841	-0.3161	-0.1870	-0.0953	-0.0531
	(-0.4355)	(-0.6383)	(-1.1342)	(-1.2697)	(-0.8638)	(-1.0507)	(-0.6920)
D1		-0.1291	-0.2797	-0.3075	-0.2051	-0.1063	-0.0636
		(-0.6062)	(-1.1026)	(-1.2206)	(-0.9396)	(-1.1620)	(-0.8221)
D2			-0.2895	-0.3016	-0.1803	-0.0647	-0.0194
			(-1.0888)	(-1.1449)	(-0.7887)	(-0.6752)	(-0.2391)
Inflation				-0.0061	-0.0127	-0.0071	-0.0049
				(-1.4418)	(-3.2164)	(-4.2126)	(-3.2822)
Demmocracy Index					-0.1352	0.0511	0.0252
					(-4.4068)	(2.9237)	(1.6084)
Commodity Exports						0.4175	-0.0576
						(15.6948)	(-0.5594)
GDPpc							2.4210
							(4.7222)
Adjusted R-squared	-0.0144	-0.0260	-0.0226	-0.0025	0.2560	0.8699	0.9082

Note: t-statistics in parenthesis.

By assessing the impact of the change in exports on Ecuador economic performance and fiscal policy we, as expected, found evidence that commodity exports increase mainly due to higher prices have had a very significant effect on the country's public both spending and investing. The level of investment in infrastructure

and the current transfers seem to have been chosen accordingly of the commodity prices' behavior. On the other hand, we found no evidence that the electoral processes have had any significant precedence on the behavior in fiscal policy nor in the democracy index.

6.5 Conclusions

In order to develop a better understanding of the Ecuadorian and by extension Latin-American young "imperfect" democracies is important to know the main features and structures that rule its functioning and what are the differences with more advanced regions. This paper sought to address these questions through the analysis of the Political Business Cycle in Ecuador for which we gathered information relevant to explain the way political decisions are made.

On one hand the president's main focus should be in theory to reach the minimal conditions for being re-elected including economic growth, low inflation and public spending. On the other hand, needs to satisfy the lobbies' demands. On the practice, unless there is a very efficient management of the economy, both actions cannot be reached. It is important to note the difficult to achieve a reelection in Ecuador, given the hard conditions the economy faces. In our data set, for instance, since the return to the democracy in 1979 this was possible only one time. We find that the intrinsic features of the Ecuadorian democracy make it difficult to engage in opportunistic (or partisan for that matter) behavior on part of political classes.

These factors unchain three possible endings: 1) If the GDP increases are high enough the incumbent president gets to the 4th year and wins the reelection. 2) If the GDP increases is mildly high the president finish its fourth year but does not try to get re-elected because of his low approval ratings, or 3) If the GDP increases are very low the president is thrown by a coup d' etat.

Our model explains that high increases in GDPpc are needed for achieving a re-election. The empirical data seems to confirm this, showing that there is indeed a correlation between economic growth and months the politicians held in office. Moreover, the evidence extracted from our model suggests that the Ecuadorian elections are very influenced by two factors: The state of the economy which depends on the price of the exporting commodities (likely to be volatile), so there is a correlation between the GDP per capita growth and the chance to finish the governance period with higher prices of commodities being a determinant factor. And the power the distinct lobbies are able to exert on the president. As stated by Barberia (2011), it is likely in unstable democracies with insufficiently matured institutions that incumbent presidents make an effort to appease lobbies mostly upper classes and military-police elites in order to maintain governance.

The model shows that neither public spending nor public investment are modified significantly during electoral times. The increase on these are strongly correlated to the volume and prices of Ecuador main commodity exports though.

6.6 Acknowledgements

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Chapter 7

Concluding remarks

7.1 Conclusions

This dissertation has focused mainly on studying the empirical facts of the Ecuadorian economy through the analysis of its Business Cycle by using different strategies, observational units and econometric approaches. In particular, we used Business Cycle Synchronization, Real Business Cycle and Political Business Cycle theoretical frameworks.

The first paper explored the Ecuadorian economy stylized facts and compared them with the theoretical assumptions. The most significant findings are the following: First, the cyclical component of both the GDP of the primary sector and the oil sector shows high volatility due to the Ecuadorian economic structure, which causes cyclical fluctuations in Ecuador to be significant. Second, the volatility of consumption is higher than that of GDP, which is evidence of deviations from the life-cycle hypothesis explained by the existence of rigidities in the credit and labor markets that cause consumption to vary significantly in response to changes in income. Third, public spending shows a very high relative variability, as well as a procyclical and coincidental behavior with economic activity. It is therefore an automatic mechanism; whereby public spending increases when public revenues are higher and decreases when public revenues fall. Finally, employment is less volatile than economic activity, which leads to procyclical behavior in labor productivity.

The second paper addressed the effects of trade in business cycle synchronization using the case of Ecuador. We conclude that in the Andean Community of Nations, the business cycles of the member countries have gone through periods of both convergence and divergence. However, there is considerable evidence that, since the 1994 integration acceleration, business cycle synchronization in the CAN area has increased. It is found that such trade intensity led to greater synchronization, however, these results suggest but do not confirm the existence of a common business cycle. On the other hand, it confirms the country's dependence on periods of economic expansion of its trading partners to stimulate its level of economic activity.

The third paper examined the policy implications for the design of fiscal policies related to oil revenues in some developing economies. We show that the fiscal rules followed by the Ecuadorian fiscal authorities, namely a budget equilibrium year by year, and a public investment rule where public investment is equal to oil revenues, reinforces the transmission mechanism from international oil price shocks to macroeconomic fluctuations, increasing the volatility of key macroeconomic variables and reducing welfare. However, the current scenario of high macroeconomic volatility and welfare cost could be reversed by introducing small and simple changes

in the current public investment fiscal rule related to oil revenues. The most adequate alternative seems to be a fiscal rule where public investment is a function of total public revenues, including both taxes and oil revenues. This alternative fiscal rule is simple and only requires a slight modification of the current fiscal rule with little political impact, by decoupling public investment from oil windfalls from international oil price fluctuations, as under this alternative rule public investment also depends on tax revenues. If Ecuador were to adopt this alternative fiscal rule, it would mitigate welfare losses due to oil price shocks and substantially reduce the volatility of the business cycle.

The fourth paper focused developing a better understanding of the Ecuadorian and by extension Latin-American young "imperfect" democracies. Thus, analysed of the Political Business Cycle in Ecuador for which we gathered information relevant to explain the way political decisions are made. The model developed explains that high increases in GDPpc are needed for achieving a re-election. The empirical data seems to confirm this, showing that there is indeed a correlation between economic growth and months the politicians held in office. Moreover, the evidence extracted from our model suggests that the Ecuadorian elections are very influenced by two factors: The state of the economy which depends on the price of the exporting commodities, so there is a correlation between the GDP per capita growth and the chance to finish the governance period with higher prices of commodities being a determinant factor. And the power the distinct lobbies are able to exert on the president. It is likely in unstable democracies with insufficiently matured institutions that incumbent presidents make an effort to appease lobbies mostly upper classes and military-police elites in order to maintain governance.