THREE ESSAYS ON FINANCIAL DEVELOPMENT MACROECONOMIC VOLATILITY AND MONETARY POLICY

A thesis submitted for the degree of Doctor of Philosophy

by

Ekaterina Glebkina

Department of Economics and Finance, Brunel University London

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Abstract

This thesis consists of three studies that cover topics in the increasingly influential field of financial development and monetary policy. Chapters 2 and 3 explore the case of Brazil by (i) investigating whether (and how differently) deposits in public and in private banks affect economic growth over extremely long-time horizons using an uncommon econometric framework and (ii) revisiting the growth-finance nexus using a new econometric approach and a new and unique data set. More specifically in Chapter 2 utilizes a PARCH framework and data for Brazil from 1870 to 2018 we find that the main explanatory factors, solely in terms of their negative lagged indirect/direct (short-run) effects on economic growth in Brazil, turn out to be the domestic financial development indicators. Further, we find robust evidence that the U.S. interest rate affects growth positively both indirectly (via its volatility) and directly (both in the short- and long-run). Our results are robust to the inclusion of other economic variables i.e. trade openness and public deficit. We also argue that domestic financial development influences growth negatively in the short-run but positively in the long-run, whereas the impact of international financial integration is positive in both cases. Furthermore, the impact of private and public ownership on economic growth tends to be both direct and indirect. However, our parameter estimations highlight the significantly higher (in absolute magnitude) negative indirect and direct short-run effects of public banks (compared to those of private banks) on growth. Finally, trade openness and public deficit influence output growth negatively in the short-run. Our results are robust to the inclusion of population, inflation, and authority score as well as dummy variables.

Chapter 3 uses the smooth transition framework and annual time series data for Brazil (i.e. annual growth rate of gross domestic product (gdp), financial development, trade openness and a set of political instability indicators) covering the period from a very long time window, from 1890 to 2003. The new data we use in this chapter is for political instability. Our research contributes further to the literature by extending the track of political instability back to the year of 1890. More specifically, we constructed our own informal and formal political instability series from 1890 to 1919 (a period with high political uncertainty in Brazil).

Our main findings are that (a) financial development has a mixed (positive and negative) time-varying impact on economic growth (which significantly depends on jointly estimated trade openness thresholds); (b) trade openness has a positive effect, whereas (c) the effect of political instability, both formal and informal, on growth is unambiguously negative.

Finally, Chapter 4 continues the investigation on the empirical magnitude of the fiscal multipliers and its determinants in the U.S.. We estimate the effects of unanticipated government spending shocks on output using quarterly U.S. data, 1986-2017. Our contribution is to estimate time-varying fiscal multipliers conditional on different states of the business cycle by smooth-transition estimation, characterising multipliers by the sign of the spending shocks.

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Publications

Chapter 2 titled 'The Finance-Growth Nexus and Public-Private Ownership of Banks in Brazil since 1870' has been published in the Annals of Operations Research (with Nauro F. Campos, Menelaos G. Karanasos and Panagiotis Koutroumpis).

Chapter 3 titled 'Financial Development, Political Instability, Trade Openness and Growth in Brazil: Evidence from a New Dataset, 1890-2003' has been published in the Open Economies Review (with Nauro F. Campos, Menelaos G. Karanasos and Panagiotis Koutroumpis).

Chapter 4 titled 'Contractionary and Expansionary Fiscal Multipliers in the U.S.' is ready for submission (with George Kapetanios, Chris Tsoukis and Panagiotis Koutroumpis).

Table of Contents

CHAPTER FOUR
Contractionary and Expansionary Fiscal Multipliers in the U.S

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CHAPTER FIVE
Contractionary and Expansionary Fiscal Multipliers in the U.S

List of Tables

List of Figures

Chapter 1

Introduction

In this thesis, Chapters 2 to 3 focus on the main driers of economic growth in Brazil whereas Chapter 4 estimates the fiscal (spending) multipliers using quarterly U.S. data, 1986-2017.

More specifically, Chapter 2 investigates whether (and how differently) deposits in public and in private banks affect economic growth over extremely long-time horizons using an uncommon econometric framework. More specifically, we focus on indirect and direct short- and long-run effects of finance on the growth rate of Brazilian gross domestic product (gdp). The Brazilian case is particularly interesting when studying the relationship between finance and economic performance. Brazil is relevant because of its size (both in terms of populations and output), its hegemonic role in South America and its relatively important role globally. Our results can be organized in three main effects: (a) indirect (via volatility), (b) direct short- and long-run and (c) structural break effects. Regarding the indirect effects we argue that the impact of domestic financial development on the conditional volatility of economic growth is negative, whereas that of international financial development is positive. Notably, our parameter estimations highlight the significantly higher (in absolute magnitude) negative indirect impact of public ownership banks (compared to that of private ownership banks). Our results are robust to the presence of trade openness and public deficit (both these variables affect growth negatively).

As for the direct short- and long-run effects, we find that domestic financial development affects growth negatively in the short- but positively in the long-run, whereas the impact of international financial integration is positive in both cases. An important finding in the finance-growth literature is that the impact of finance on growth tends to be positive in the long- but negative in the short-run. Our estimates add a novel element to this by documenting such a pattern only for private (not for public) banks. Furthermore, there is a significantly higher (in absolute magnitude) negative short-run impact of public ownership banks (compared to that of private ownership banks). Trade openness and public deficit have a negative influence on growth that is restricted in the short-run.

Finally, we subjected all these results to the presence of structural breaks. This is an important exercise given the very long-term nature of the data. We find that the basic results remain once structural breaks are taken into account. A noteworthy aspect of these findings is that (i) the indirect effect of public bank ownership is stronger before the start of the Great War, 1911, and (ii) the indirect role of private bank ownership intensifies after 1962. The latter indicates the increasing role of private ownership in economic growth of Brazil during a period which coincides with the so-called "Economic Miracle" era. In short, the main results from this analysis suggest that financial development (domestic and international) exhibits robust first-order effects on growth and its volatility. Trade openness and public deficits play important yet secondary roles. In our view, this is because the effects of these variables do not extend to the long-run.

Chapter 3 chiefly addresses the following questions: What is the relationship between economic growth, on the one hand, and financial development, trade openness and political instability, on the other? Does the intensity and sign of these effects vary over time? Has the transition between such possible regimes been often smooth or has it generated substantial costs and negative externalities?

Few previous studies have tried to evaluate how the explanatory power of these factors has changed over time and this is one of the main contributions of this Chapter. This Chapter tries to contribute to the existing literature by further investigating the time-varying link basically between finance, political instability and economic growth. It uses the smooth transition framework and annual time series data for Brazil (i.e. annual growth rate of gross domestic product (gdp), financial development, trade openness and a set of political instability indicators) covering the period from a very long time window, from 1890 to 2003. The new data we use in this chapter is for political instability. The existing measures of both formal and informal political indicators for Brazil are yearly from 1919 to 2003 with the exclusion of the World War II period (1940–1945). Our research contributes further to the literature by extending the track of political instability back to the year of 1890. More specifically, we constructed our own

informal and formal political instability series from 1890 to 1919 (a period with high political uncertainty in Brazil).

Our main findings are that (a) financial development has a mixed (positive and negative) time-varying impact on economic growth (which significantly depends on jointly estimated trade openness thresholds); (b) trade openness has a positive effect, whereas (c) the effect of political instability, both formal and informal, on growth is unambiguously negative. Our findings (with respect to point (a) and (b)) provide supporting evidence on the implications of the theoretical model of Antras and Caballero (2019) who argue that when variation in financial development is a significant determinant of comparative advantage, trade flows (as well as capital flows) becomes complement in financial underdeveloped countries.

Chapter 4 estimates the effects of unanticipated government spending shocks on output using quarterly U.S. data, 1986-2017. Our contribution is to estimate time-varying fiscal multipliers conditional on different states of the business cycle by smooth-transition estimation, characterising multipliers by the sign of the spending shocks. Spending shocks are identified through professional forecasts of the growth in government spending. Methodologically, in order to obtain impulse responses, we employ the local projections method, coupled with state-dependence of the parameters of the lag polynomial (the states being recession and expansion). The state-dependent parameters are linearly combined by a time-varying weight (transition function) which is contingent on the state of the economy.

We present two sets of fiscal (expenditure) multipliers: the present-value impulse responses of output (PVIR-FMs) of an $1 unexpected shock for two horizons (H=4,8); this multiplier is our primary focus as it measures the pure output effect of shocks. We also present the present-value output responses minus the effects (present-value impulse responses) of the shock on subsequent government spending itself for the same horizons - the 'fiscal efficacy coefficients', FEC-FMs. The latter type of multiplier has been discussed by some literature, notably Mountford and Uhlig (2009) and Ramey (2019). The argument for it is that it is a measure of financial efficacy (output minus fiscal cost), of the shock, hence the name; on the other hand, its estimate is compounded by the behaviour (cyclicality and/or mean reversion) of government spending, so it is of secondary importance for our purposes. The behaviour of government spending merits further analysis in future work. Our main outcomes are summrized below.

All results are in line with theory and intuition. They suggest, that (a) the fiscal consolidations on average have a numerically stronger effect than the expansionary shocks (as well as of opposite signs); and (b) the effects of shocks are in most models countercyclical (in terms of absolute values). Finally, our results show (c) persistence of the effects of all shocks. There is also overwhelming statistical significance between the estimated coefficients in the regressions applied separately to negative and the positive shocks. In other words, in terms of estimated coefficients, the regressions are clearly not the same or even similar.

Chapter 5 concludes and provides directions for future research.

Chapter 2

The Finance-Growth Nexus and Public-Private Ownership of Banks in Brazil since 1870

2.1. Introduction

How does finance affect economic growth? And how does ownership matter? This chapter investigates whether (and how differently) deposits in public and in private banks affect economic growth over extremely long-time horizons using an uncommon econometric framework. More specifically, we focus on indirect and direct short- and long-run effects of finance on the growth rate of Brazilian gross domestic product (gdp). The Brazilian case is particularly interesting when studying the relationship between finance and economic performance. Brazil is relevant because of its size (both in terms of populations and output), its hegemonic role in South America and its relatively important role globally.

Within a power-ARCH (PARCH) framework and using annual time series data for Brazil covering the period from 1870 to 2018, the aim of this chapter is to put forward answers to the following questions. What is the relationship between finance, economic growth and volatility? Are the effects of these changes in financial development direct (on economic growth) or indirect (via the conditional volatility of growth)? Does the intensity and sign of these impacts vary over time? Does the intensity of these effects vary with respect to short- versus long-run considerations? Is the intensity of these effects constant across the different eras or phases of Brazilian economic history (in other words, are they independent of the main structural breaks we estimate)?

There is an extensive literature on the finance and growth nexus. Its main objective is to establish whether financial development causes economic growth and to identify and understand the main mechanisms through which this occurs (cf. Demirguc-Kunt et al., 2013, and references therein). Our econometric results support, as the main finding, the notion that the development of financial institutions should occupy centre stage in understanding the process of economic growth. For the case of Brazil it is found to have more direct and robust impacts than, for instance, trade openness. Hence the chapter relates closely to the literature on the finance-growth nexus.

Schumpeter (1911) argues that entrepreneurs need credit to finance new production techniques. Banks are considered as key players in facilitating the aforementioned activities and promoting economic development. Therefore, well-developed financial institutions could be an efficient mechanism to direct financial resources to the most productive sectors of the economy. Schumpeter (1934), Gurley and Shaw (1955) and Goldsmith (1969) argue that financial development is central to economic growth, while Hicks (1969) illustrates this case by documenting how financial development drove industrialisation in England by encouraging flows of capital.

Moreover, the aforementioned scholars highlight the importance of advancing policies targeted at developing the financial system in order to promote economic growth, for instance by creating more financial institutions and offering a greater variety of financial services and products, in order to achieve a positive impact on the saving–investment process, and hence on growth (see for more details Ang, 2008). Nevertheless, this approach had little effect on promoting policy making, first due to the fact that it was not suggested in a "formal manner", and second due to the domination of the Keynesian ideology (Ang, 2008).

More recent endogenous growth scholarship concludes that the financial sector plays a constructive role in the economy (Bencivenga and Smith, 1991). In addition, financial development leads to more efficient allocation of resources, reduces uncertainty and transaction costs, and promotes more rapid capital accumulation and technological advancement (Roubini and Sala-I-Martin, 1992; King and Levine, 1993; Greenwood and Smith, 1997; Levine, 1997; Levine, 1999; Levine, 2005). It should be noted, however, that authors such as Gavin and Hausmann (1996), and Loayza and Rancière (2006) argued that in the short-run financial liberalisation and expansion without any constraints could cause banking crises and thus economic collapse. Kar et al. (2011) highlight the difficulty in establishing the exact relationship

between economic growth and financial development and argue that there is no clear evidence on the direction of the causality between them.

So far empirical research has been dominated by cross-country studies on the impact of financial development on growth. This is due to lack of availability of data for developing economies. The majority of these cross-country studies highlight the beneficial effect of financial development on growth (see King and Levine, 1993a; Rajan and Zingales, 1998; Levine et al., 2000 and Rioja and Valev, 2004). However, generalizing and applying their findings in each country could impose serious challenges since the nature and way of operating of financial institutions is substantially different from country to country (see Arestis and Demetriades, 1997; Demetriades and Andrianova, 2004 and Ang, 2008). This chapter tries to improve matters in this regard by focusing on a single country (as opposed to following the common practice of trying to learn something about growth by focusing on the mean or median country).

We believe this study can further our understanding about economic growth because: (a) we study only one individual country over a very long period of time with annual frequency data[1], (b) we provide new evidence about the public-private ownership of banks in Brazil since 1870 (this is the first study to the best of our knowledge that addresses the issue of public vs private bank ownership for the Brazilian case since 1870), and (c) we choose an econometric methodology that has been seldom used in the empirical growth literature despite the fact that it easily allows us to contrast the direct (short- and long-run impacts) to the indirect (i.e., via the volatility channel) effects of each of our candidate reasons, and distill the consequences of accounting for important structural breaks on the robustness of our key results.

Another important benefit of our choice of econometric framework is that it helps to shed light on an important and resilient puzzle about the relationship between output growth and its volatility. While Ramey and Ramey (1995) show that growth rates are adversely affected by volatility, Grier and Tullock (1989) argue that larger standard deviations of growth rates are associated with larger mean rates. The majority of ARCH papers examining the growth-volatility link are restricted to these two key variables. That is, they seldom assess whether the effects of the presence of other variables affect the relation and, on the rare occasions that happens, it is usually inflation and its volatility that comes into play.[2] One contribution of this chapter is to study if and how the growth-volatility relationship changes in light of a wider set of variables. Note also that the use of annual data allows us to perform a more appropriate test of the hypothesis that predicts a positive effect of output variability and uncertainty on the growth rate of output.[3]

Our results can be organized in three main effects: (a) indirect (via volatility), (b) direct short- and long-run and (c) structural break effects. Regarding the indirect effects we argue that the impact of domestic financial development on the conditional volatility of economic growth is negative, whereas that of international financial development is positive. Notably, our parameter estimations highlight the significantly higher (in absolute magnitude) negative indirect impact of public ownership banks (compared to that of private ownership banks). Our results are robust to the presence of trade openness and public deficit (both these variables affect growth negatively).

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[1] Some studies access Brazil's performance for a cross-country perspective (Loyaza and Rancière, 2006), while others are more focused on the period from the 1930's onwards-trying to explain the growth rate of Brazil in the period 1930-1997 (Abreu andVerner, 1997).

[2] For a comprehensive review of this literature see Fountas et al. (2006). In addition, Gillman and Kejak (2005) bring together for comparison several main approaches to modeling the inflation-growth effect by nesting them within a general monetary endogenous growth model with both human and physical capital.

[3] Black (1987) argues that investments in riskier technologies will be pursued only if the expected return on these investments (expressed as the average rate of output growth) is large enough to compensate for the extra risk. As real investment takes time to materialize, such an effect would be more likely to obtain in empirical studies utilizing low-frequency data.

Finally, we subjected all these results to the presence of structural breaks. This is an important exercise given the very long-term nature of the data. We find that the basic results remain once structural breaks are taken into account. A noteworthy aspect of these findings is that (i) the indirect effect of public bank ownership is stronger before the start of the Great War, 1911, and (ii) the indirect role of private bank ownership intensifies after 1962. The latter indicates the increasing role of private ownership in economic growth of Brazil during a period which coincides with the so-called "Economic Miracle" era. In short, the main results from this analysis suggest that financial development (domestic and international) exhibits robust first-order effects on growth and its volatility. Trade openness and public deficits play important yet secondary roles. In our view, this is because the effects of these variables do not extend to the long-run.

The chapter is organized as follows. Section 2.2 provides the related literature on the link between financial development and Brazilian economic growth. Section 2.3 describes the data and Section 2.4 provides details and justification for our econometric methodology. Section 2.5 presents our baseline econometric results. Section 2.6 concludes and suggests directions for future research.

2.2. Related Literature

One of the most important contributions to the study of long–term Brazilian economic growth is Abreu and Verner (1997). They studied the contribution of financial development, with emphasis on the period 1930–1990. They did not find evidence that financial development boosted growth. They argued that increased public sector savings proved (disappointingly) to have only a small impact on gdp, and attempts to include monetary variables as explanations for either short-term or long-term economic growth in Brazil came to naught. According to them, financial development fails to explain the economic growth in Brazil in this particular period. However, our results present a different story for the following reasons. By using a different econometric approach and longer-term data, we find that financial development affects long-term growth positively, whereas the short-run impact is negative and robust. In other words, we differentiate by reporting that domestic financial development affects growth negatively in the short-run but positively in the long-run (whereas the positive short-run impact of international financial integration disappears in the long-run). Our estimates add a novel element to this by documenting such a pattern only for private (not for public) banks.[4]

Recent studies on either Latin America or Brazil have covered this particular period and have paid attention to the study of financial development. Bittencourt (2012) finds that financial development played a significant role in promoting growth in Latin America. Castelar et al. (2004) examined the link between financial development, growth and equity. Also, Stefani (2007) investigated this relationship in Brazil between 1980 and 2006 by using cointegration methods. Further, some papers shed some light on how relative factors like interest rates and inflation affect Brazil's recent growth (see Muinhos and Nakane, 2006 and Vale, 2005). Most of these papers concluded that there was a strong positive relationship between financial development and output growth in Brazil, yet they have not investigated this relationship over the long-term, and nor have they assessed whether this is a more or less important reason vis-a-vis the other important factors economic historians normally highlight (such as trade openness, public finances, and inflation or macroeconomic instability).

de Paiva Abreu (2006) evaluates Brazilian external borrowing throughout the 19th and early 20th centuries in their 2006 paper "Brazil as a debtor, 1824–1931". The analysis compares Brazilian loan interest rates to British and U.S. government consol rates throughout the period from 1824 until 1931. According to the study Brazilian loan interest rates exceeded those of the period when lending to Brazil was considered high risk. The research explores the political instability and economic conditions that affect Brazil's creditworthiness status. It also demonstrates that external debt directly impacted Brazil's economic growth along with its incorporation into the global financial system. Through historical financial data the author evaluates Brazil's borrowing expenses over time. The study demonstrates the difficulties that developing nations encountered while accessing international capital markets throughout the 19th and early 20th centuries. Brazil has achieved some level of convergence with select countries according to Dore and Teixeira (2022) but the nation remains separated from wealthy nations. Long-term development

[4]For a brief summary of our contribution and additional testing that focuses on the period 1930-1990 please see the robustness check section below as well as the Online Appendix 1.

remains limited due to the insufficient human capital and weak institutions which originated from Brazil's colonial history.

The Rothschild bank protected its overseas creditor reputation through the 1898 emergency loan which stabilized Brazil according to Weller (2015). The imperial government maintained equilibrium between theoretical monetary policies and practical crisis measures while resolving disputes with private banks and the planter elite throughout the 1850 to 1870 period according to Villela's (2020) paper. Finally, Fritscher and Musacchio (2010) demonstrate that Brazilian states obtained lower borrowing costs from their ability to tax exports through fiscal federalism between 1891 and 1930. The capital costs of wealthier states remained lower which allowed them to make more investments but poorer states accumulated more debt leading to increased regional economic disparities.

To better understand the Brazilian case and its standing in the world economy we provide a brief comparison of prosperity (proxied by per capita gdp) between Brazil and other nations from Latin America and Western Europe. To accomplish this we plot (and compare) the level of Brazilian per capita gdp against that of Latin American (namely Argentina, Chile, Colombia, Uruguay and Venezuela) and Western European Countries (i.e. France, Germany, Portugal, Spain and United Kingdom) for the period 1870 to 2016 (obtained from Bolt et al., 2018). More specifically, Figures A1.a and A1.b in the Appendix 1 report the level of Brazilian per capita gdp relative to Latin American and Western European countries respectively. The graphs show that Brazil has the lowest economic prosperity compared to both groups of countries by a considerable amount for most of the sample period.

The region of Latin America consists of a number of countries that experienced various degrees of financial development and economic prosperity. Figure 2.A1.a suggests that despite the fact that most Latin American countries displayed comparable degrees of economic uncertainty the Brazilian economic welfare was only comparable to that of Colombia and Venezuela till around 1910, although well behind after that period. On the other habd Argentina, which faced a magnitude of political unrest similar to that of Brazil, enjoyed much higher economic welfare.

In sum, the period since 1870 is an important one in Brazil as it sees the country's economic take-off and it becoming an emerging market.[5] However, there is still debate about which factors better explain this remarkable transformation. Financial development (both domestic and international) is one of the main reasons often highlighted by economists and economic historians. The main objective of this chapter is to evaluate the relative merits of the factors behind these explanations. More specifically, we try to contribute to the literature by studying how financial development and bank ownership affected the process of economic growth in Brazil.

2.3. Data

The data set we put together for this chapter covers the period between 1870 and 2018 for Brazil. The basic data source is Mitchell (2003). Data were recorded yearly including: the growth rate of gdp at level[6] (*gdp*), deposits in commercial banks over gdp (*cbd*), deposits at Bank of Brazil over gdp (*dbb*), and money supply 1 over gdp (*m1*).[7]

Based on the literature on growth and finance (Levine, 2005, Campos et al., 2012 and Campos et al., 2016) we use a broad range of measures of financial development, some reflecting depth and others efficiency aspects. One note of caution is that there are various aspects of financial development which may be considered important but for which data are only available after about 1950 or 1960 (e.g., share of credit to the private sector over gdp, intermediation spreads, bank credit and bank credit/deposits ratio) and hence cannot be used in the present study.

Cbd is defined as the sum of time deposits in commercial banks and deposits (other than time deposits) at the end of the period in commercial banks over gdp, and alongside *dbb* it tries to capture the efficiency of the financial sector and not its relative size (see Campos et al., 2012 and Campos et al., 2016). Data

[5] See Appendix 1 for a short summary of the Brazilian economic background since 1870.

[6] Furthermore, for robustness purposes we downloaded the Maddison growth rate of per capita gdp introduced by Bolt and Van Zanden (2014) and plotted it against our growth rate of gdp. The two lines were significantly intertwined (graph available upon request).

[7] The money standards of the data changed from time to time and figures are often incomplete for a given subperiod. Therefore, in order to find relatively complete series to avoid bias as much as possible, other resources are included i.e. the Federal Reserve Bank of St' Louis, U.S.A (FRED).

have been reported by Mitchell (2003) but due to missing values we follow Pelaez and Suzigan (1976) to reconstruct the series. The second financial development indicator, *dbb*, is measured by the added value of time deposits and deposits (other than time deposits) at the end of the period in the central bank over gdp. *Cbd* and *dbb* serve as proxies of the private and public bank ownership respectively. The third and final one is *m1* (retrieved from Mitchell, 2003). One potential drawback of this measure is that the ratio reflects the depth or the relative size of the financial system and not its efficiency. Given *m1*'s and *dbb*'s more restrictive nature we use both of them as a robustness check of our results and thereby we attach greater weight to commercial bank deposits (as a proxy of domestic financial development).

Our two financial development indicators, namely *cbd* and *dbb*, will allow us to conduct a deeper analysis of the issue of ownership, a topic that has not been sufficiently studied in the frame of the finance-growth nexus literature. Does ownership matter? How do payoffs in terms of economic growth vary according to whether financial development is in the form of deposits at public or at private banks? We construct historical data series that separate deposits at private banks from those in public banks. Our data for deposits at commercial banks exclusively covers private banks. On the other hand, Bank of Brazil today is a public bank and has been a state-owned bank for most of its history. Yet its history has been long and convoluted: Bank of Brazil was founded in 1808 and is the oldest (and largest by assets) financial institution in Latin America. It was bankrupt twice (in 1821 and 1898) and changed name, structure and functions many times.[8]

Because the Brazilian Central Bank was created only after World War II, Bank of Brazil has for long periods performed several of its tasks (e.g., issuing currency, having a monopoly over currency transactions and serving as Treasury holder). The head of the Bank of Brazil has always been a political appointment, nominated by the President. Although these gradations and changes are clearly important and do raise some caveats, it is also clear that Bank of Brazil is best classified throughout its history as a public-owned bank. This is broadly accepted in the literature (cf. Berg and Haber, 2009, and Goldsmith, 1986) and is thus followed here.

We also use data on various factors often utilized to explain the economic performance of Brazil over the long-run (cf. Abreu and Verner, 1997) such as international financial development, trade openness, and public deficit. Despite the fact that in the period since 1930 Brazil remained a closed economy, international financial development is expected to have played a significant role in Brazil's economic growth. Abreu and Verner (1997) argue that from 1930-1980 Brazil had a unique foreign economic orientation, with bold export promotion policies and a rather closed domestic market. We use the level of interest rate in U.S. (*us*) as our proxy of the global financial market. The U.S. interest rates are obtained from Friedman and Schwartz (1982).[9] The measures of trade openness (*to*) and public deficit (*pd*) were obtained from Mitchell (2003) and the Brazilian Institute of Geography and Statistics-IBGE (2007). Trade openness is measured as the ratio of imports plus exports to gdp, while public deficit is the ratio of total public deficit to gdp. Because the original series (with the exception of growth rate of gdp) are I(1), they enter our models in first differences for stationarity purposes. All data are graphically illustrated in Figures 2.1 to 2.7 (with the exception of growth rate of gdp the rest of the series are plotted in first difference). Table B in the Appendix 1 provides the definitions and data sources of the variables used in the regression analysis. We also plot the data at level in Figures 2.8 to 2.17 in the Appendix 1.

2.4 The Model

2.4.1 Power ARCH Specification

In order to study the indirect effects of our set of explanatory variables we employ the PARCH model of Ding et al. (1993), which quickly gained currency in the finance literature.[10] Let growth (y_t) be equal

[8] Haber in his discussion on the Brazilian economy during the late 1890s states: "The banking system then began to expand, led and controlled by a semi-official super-bank, the third Bank of Brazil, which acted both as a commercial bank and as the treasury's financial agent" (2003, p. 271).

[9] Due to the historic perspective of the paper and the lack of available data, the U.S. interest rate is used as a proxy for international financial development. However, we do acknowledge the fact that if the U.S. interest rate affects any variable in the home country, it also means that it would systematically impact the home country gdp as well at some point through some direct or indirect channels. Data were also obtained from FRED.

[10] See, for example, Karanasos and Kim (2006). Karanasos, Schurer (2005, 2008) and Canepa et al. (2023) use this process to model output growth and inflation respectively.

to a drift plus a time-varying disturbance augmented by the in-mean effect of output volatility on output (h_t):

$$y_t = c + k\log(h_t) + \epsilon_t, \tag{2.1}$$

with $\epsilon_t = e_t h_t^{\frac{1}{2}}$ and k captures the effect of volatility on growth. In addition, $\{e_t\}$ are independently and identically distributed (i.i.d) random variables with zero mean and unit variance, while h_t is the conditional variance of output growth, which is positive with probability one and is a measurable function of the sigma-algebra Ω_{t-1}, which is generated by $\{y_{t-1}, y_{t-2}, \ldots\}$.

The conditional variance of growth is specified as a symmetric PARCH$(1,1)$ process:

$$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}}|e_{t-1}|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}} + \sum_{i=fd,to,pd,us} \phi_i x_{i,t-l} + \gamma y_{t-n}, \tag{2.2}$$

where δ (with $\delta \in (0,\infty)$) is the heteroscedasticity parameter, l and $n \in \mathbb{Z}_{\geq 1}$; α and β are the ARCH and GARCH coefficients respectively, x_{it} is either the financial development variable or one of the other explanatory variables,[11] namely trade openness, public deficit and U.S. interest rate and γ is the level coefficient for the nth lag of growth. The model imposes a Box-Cox power transformation of the conditional standard deviation process and the absolute residuals, [following Ding et al. (1993) asymmetric effects were initially considered in our model, though the coefficients were insignificant and hence omitted from the analysis]. In order to distinguish the general PARCH model from a version in which δ is fixed (but not necessarily equal to two) we refer to the latter as (P)ARCH.

The PARCH model increases the flexibility of the conditional variance specification by allowing the data to determine the power of absolute residuals for which the predictable structure in the volatility pattern is the strongest. This feature in the volatility process has important implications for the relationship between financial development, growth and its volatility. There is no strong reason for assuming that the conditional variance is a linear function of lagged squared errors. The common use of a squared term in this role is most likely to be a reflection of the normality assumption traditionally invoked. However, if we accept that growth data are very likely to have a non-normal error distribution, then the superiority of a squared term is unwarranted and other power transformations may be more appropriate. If observations are adjusted by a sign-preserving power transformation specified by a modified PARCH parameterization, then the PARCH model is a standard GARCH model. The heteroscedasticity parameter is probably different when added to a typical Bollerslev type model, as suggested by He and Teräsvirta (1999). Like other power terms, squaring growth rates gives the data a structure that may lead to less-than-ideal modeling and forecasting performance. Sample autocorrelations of power transformed absolute growth $\mid y_t \mid^d$over various positive values of d are investigated to test this assumption's seriousness. Figure A2 shows the autocorrelogram of $\mid y_t \mid^d$ from lag 1 to lag 20 for $d = 0.8, 1.0, 1.5, 2.0$ and 2.5. If the process y_t is *i.i.d.*, the horizontal lines display the estimated sample autocorrelation's $\pm 1.96/\sqrt{T}$ confidence interval (CI). In our case $T = 149$, so $CI = \pm 1.96/\sqrt{T} = \pm 0.16$. The sample autocorrelations for $\mid y_t \mid^{0.8}$ are greater than the sample autocorrelations of $\mid y_t \mid^d$ for $d = 1.0, 1.5, 2.0$ and 2.5 at every lag up to at least 11 lags. In contrast, at $d = 0.8$, the waning autocorrelation is greatest and slowest for $\mid y_t \mid^d$. Moreover, notice that lags are least autocorrelated when d is 2 and 2.5 for the majority of the lags of $\mid y_t \mid^d$. The sample autocorrelations of the absolute growth $\rho_\tau(\delta)$ as a function of δ for lags $\tau = 1, 5, ..., 30$ and taking $\delta = 0.125, 0.25, ..., 4.0$ are computed to study the PARCH process selection further. Figure A3 reports the calculated $\rho_\tau(\delta)$. For instance, for lag 1, there is a unique point δ^* equal to 0.8 for the absolute growth, such that $\rho_1(\delta)$ reaches maximum at this point: $\rho_1(\delta^*) > \rho_1(\delta)$ for $\delta \neq \delta^*$. We additionaly utilize the Wald test to investigate whether the estimated power term differs from two (significantly). The predicted power coefficient differs significantly from two (see Panel A of Table 2.A.2 below). Furthermore, we choose the best fitting model based on the Likelihood Ratio (LR) results and the minimum value of the Akaike Information Criterion (AIC), please see Panel B of Table 2.A.2 for a sample of those findings. These outcomes provide evidence against Bollerslev's specification and empirical validation of the PARCH process. Finally, the statistical significance of the in-mean effect depends (highly) on the selection of the heteroscedasticity's parameter size. If the power term exceeds a certain level, the previousy indicated effect may become statistically insignificant. The latter implies that

[11] Because the original series are I(1), they enter our models in first differences for stationarity purposes.

assuming a linear relationship between a variable and its uncertainty a priori, may result in the absence of a significant association between the two.

The Tables below report the estimated parameters of interest for the period 1870-2018. These were obtained by Quasi-Maximum likelihood (QML) estimation, which is robust to the presence of normality as implemented in EVIEWS and described by Bollerslev and Wooldridge (1992). Once heteroscedasticity has been accounted for, our specifications appear to capture the serial correlation in the power transformed growth series. Moreover, the tests for remaining serial correlation suggest that all the models seem to be well-specified since there is no remaining autocorrelation in either the standardized or squared standardized residuals at 5% statistical significance level (due to space limitations results are not tabulated but are available upon request). We also run the ARCH effect tests in the underlying data. For all of our variables the results show rejection of the null hypothesis of homoscedasticity in the squared residuals. See Table 2.A.1 in the Appendix 1. In our chapter we do not run the indirect and direct effects concurrently because with annual data we do not want to overparametrize our model.

Furthermore, our set of variables comprises domestic and international financial developments and it allows us to investigate how differently deposits in public vis-a-vis in private banks affect economic growth. As a robustness check we estimate our model using $\sqrt{h_t}$ for the in-mean effect. We also estimate it using an EGARCH specification. The results (not reported) are qualitatively similar to the ones we report in the chapter.

2.4.2 Error Correction Model

We also investigate the direct short- and long-run effects on economic growth. In order to estimate the direct short- and long-run relationships we employ the following error correction (P)ARCH form

$$\Delta y_t = \mu + \sum_{i=fd,to,pd,us} \theta_i \Delta x_{i,t-l} + \varphi(y_{t-1} - c - \sum_{i=fd,to,pd,us} \zeta_i x_{i,t-1}) + \varepsilon_t, \tag{2.3}$$

where θ and ζ capture the direct short- and long-run effects respectively, and φ is the speed of adjustment to the long-run relationship (we recall that x_{it} denotes the first difference of the explanatory variable). This is accomplished by embedding a long-run growth regression into an autoregressive distributed lag (ARDL) model (see, for example, Loayza and Rancière, 2006, and Campos et al., 2012, 2016). In other words, the term in parenthesis contains the long-run growth regression, which acts as a forcing equilibrium condition:

$$y_t = c + \sum_{i=fd,to,pd,us} \zeta_i x_{it} + u_t, \tag{2.4}$$

where u_t is $I(0)$.[12] The lag of the second difference of either the financial development (domestic or international) or trade openness or public deficit ($\Delta x_{i,t-l}$) characterizes the direct short-run effect. The condition for the existence of a long-run relationship (dynamic stability) requires that the coefficient on the error-correction term be negative and not lower than -2 (that is, $-2 < \varphi < 0$). [13]

We also take into account the PARCH effects by specifying the error term ε_t as follows:

$$\varepsilon_t = e_t h_t^{\frac{1}{2}}, \tag{2.5}$$

where

$$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}} |e_{t-1}|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}. \tag{2.6}$$

[12] Notice that all variables are $I(0)$ in the long-run growth regression, that is eq. (2.4). In addition, notice that in eq. (2.3) all regressors are lagged.

[13] Notice that we can estimate eq. (2.3) in two steps as in Loayza and Rancière (2006). That is, first estimate the long-run slope coefficients (ζ_i) in eq. (2.4). In this case, and as all data in eq. (2.4) is $I(0)$, with stationary data the long-run parameters from an ordinary least squares (OLS) regression are not super consistent. Therefore, since in the long-run estimation contemporaneous variables are involved, it would require the use of instrumental variables (IV); see for example, Hunter et al., 2017, pp. 50-51 and the examples in Chapter 8. Second, the estimation of the short-run coefficients (including the speed of adjustment φ) is done through conditional maximum likelihood and using the estimates of the long-run slope coefficients previously obtained. Alternatively, we have recalculated the parameters on $x_{i,t-1}$ in eq. (2.3) using a one step linear estimation, see robustness check in Section 2.5.1 below for further discussion.

2.5 Empirical Results

In this section we report our main results in two blocs: the indirect and the direct (short and long-run) effects. We start our analysis with the estimation of the (P)ARCH$(1,1)$ models in eqs. (2.1)-(2.2), and (2.3)-(2.6) in order to take into account the serial correlation observed in the levels and power transformations of our time series data. Tables 2.1 and 2.2 below report the estimated parameters of interest for the period 1870-2018. Our results are presented following specific types of effects. That is, we discuss indirect (via volatility), direct (short- and long-run), public vis-a-vis private bank ownership and structural break effects.

2.5.1 Indirect and Direct Effects

Indirect Effects

One of the main advantages of the (P)ARCH framework is that it allows us to study indirect growth effects from the full set of explanatory variables described above on economic growth through the predicted component of growth volatility (conditional on its past values). Table 2.1 reports the indirect effects for each of the explanatory variables on growth via the volatility channel.[14] As we can see from this Table, the effect of conditional or predicted volatility on growth is in all cases positive ($k > 0$) and statistically significant at high levels. The power term coefficients δ are rather stable, with the Akaike IC (AIC) criteria choosing a (P)ARCH specification with power term in most of the cases equal to 1.00. In the current analysis, we present our results for the indirect impacts on growth.

The parameters we are most interested in are ϕ_{fd} and ϕ_{us} (see columns 3 and 6). We find that the (indirect) impact of domestic financial development on the conditional volatility of economic growth is negative and statistically significant, whereas that of U.S. interest rate is positive. Interestingly, the size of the effect (in terms of magnitude) for public bank ownership is higher than that for private bank ownership ($0.37 > 0.09$). These results are robust to the presence of trade openness and public deficit, which also affect volatility negatively.

Our results suggest that exogenous increases in domestic financial development have a negative and significant indirect impact on growth (notice that the lagged short-run direct effect is also negative; see the analysis below). In other words, more financial development is associated with a lower proportion of growth volatility, which is anticipated by the relevant economic agents. Moreover, the lower the share of the growth volatility that is anticipated, the lower the growth rates we observe (supporting the Black hypothesis).

On the other hand, higher U.S. interest rates are associated with a larger proportion of growth volatility and the larger the share that is anticipated by agents, the higher the growth rates we observe. Therefore, international financial integration registers a positive influence on growth, which is also both indirect and direct (see below the short- and long-run effect). This is intuitive, as reductions in the U.S. interest rate lead to a reduction of the price of money internationally, which in turn leads to reduced levels of risk. This result, according to international empirical evidence, is becoming increasingly characteristic of internationalized economies.

Furthermore, both trade openness and public deficit have a negative indirect impact on growth. Interestingly, this negative influence reflects one of the costs many economists associate with trade liberalization and fiscal consolidation efforts: in the short-run, reductions in the share of trade and public deficit in gdp increase the amount of growth volatility that economic agents are not able to anticipate ($\phi < 0$). This higher volatility translates into higher rates of economic growth (since $k > 0$).

In summary, we find strong evidence that domestic financial development has a negative indirect (via volatility) impact on growth whereas U.S. interest rate (international financial development proxy) affects it positively. Trade openness and public deficit affect volatility negatively. Finally, for all the set of our explanatory variables, both the indirect and direct short-run effects work in the same direction. We now turn to the investigation of the direct short- and long-run effects.

[14] In the expressions for the conditional variances reported in Table 1, various lags of growth (from 1 to 12) were considered with the best model ($n = 8$) chosen on the basis of the minimum value of the AIC.

Direct Short- and Long-Run Impact

Table 2.2 displays the results on the estimation of the direct short- and long-run parameters linking our explanatory variables with growth. In all cases, the estimated coefficient on the error correction term (φ) lies within the range -0.77 to -0.51 which is well within the dynamically stable range $(-2, 0)$. We find important differences in terms of direct short- and long-run behaviour of our explanatory variables. More specifically, we focus our analysis first on those obtained from the domestic financial development. In the short-run, we find that it affects growth negatively (see the θ_{fd} column in Table 2), whereas in the long-run the impact is positive (only for the case of m1 and cbd, see the ζ_{fd} column). Thus, our results square well with recent findings by Loayaza and Rancière (2006), among others, in that the sign of the relationship between economic growth and financial development depends on whether the movements are temporary or permanent (the effect being negative in the former and positive in the latter case). On the other hand, our parameter estimates report a positive short- and long-run influence of international financial development on growth (see the θ_{us} and ζ_{us} columns respectively). The latter finding is similar to the one reported by Campos et al. (2012) for Argentina. The results for trade openness and public deficit indicate a negative impact on growth that is restricted in the short-run.

In summary (see also Table 3), we find that domestic financial development affects growth negatively in the short-run but positively in the long-run, whereas the impact of international financial integration is positive in both cases. Overall, we argue that both domestic and international financial development have an important direct role in the economic growth of Brazil. Interestingly, the short-run effects of the international financial development are in the opposite direction from those of domestic financial development. Furthermore, public deficit and trade openness also play a significant role in Brazilian growth but only in the short-run.

Our findings with respect to financial development and trade openness reveal an interesting aspect of the forces that drive the Brazilian economic growth. In particular, the negative (direct) short-run impact of domestic financial development and trade openness on growth suggests that emerging markets, such as Brazil (with an economy oriented towards exporting primary goods, i.e. soybeans, sugar and coffee among others), that attempt either (i) to expand their weak domestic financial systems without promoting financial reforms (substantial financial sector reforms took place in Brazil as early as in the 1960s) or (ii) to increase their exposure/openness to trade without adopting to new technologies to achieve economies of scale, experience negative economic outlooks in the short-run. As far as the negative effect of public deficit on growth is concerned, our estimates bring to the surface the long-standing discussion among macro-economists on the importance of the rationalization of public spending in order to maintain a benign macroeconomic environment and social tranquillity.

Robustness Check

The existing theoretical as well as empirical literature on the growth-finance relationship postulates that in a bank-based financial system, bank credit is the major instrument of financial intermediation through which financial development transmits the effects on growth. Credit-deposit as well as credit-to-gdp ratio may also be considered as another measure of the efficiency of financial intermediation at a given level of deposits (data were available for a very short period of time, 1973 onward, and hence this measure of financial development was omitted from our analysis).

To corroborate our results further we considered in our analysis the growth rate of bank credit in all commercial banks (bcc), which was obtained from the Federal Reserve Bank of St' Louis as an additional measurement of financial development efficiency. However, the data were only available for the period 1948 to 2018. The indirect negative influence of this variable confirms our baseline results. The direct short- and long-run effects were statistically insignificant and are hence omitted from our modelling. Finally, due to the historical nature of this chapter data on fintech and digital payments were not available.

However, before proceeding we must note that one possible important drawback of the identification strategy is omitted variable bias. To address this issue, we control for the effect of inflation rate (inf), population (pop), and regime and regulatory authority (reg), measured by the authority score (this indicator is computed by substracting the autocracy score from the democracy score, for more details see Table 2.B), and examine whether controlling for these three variables the effects of our key domestic

financial development measurements become weaker, stronger or remain unchanged.[15] With regards to the indirect effects, our results indicate a negative (positive) effect of inflation (population and regulatory authority) on economic growth, (see the parameter estimates ϕ_{reg}, $\phi_{\inf}$ and ϕ_{pop} in Table 2.1a respectively). As for the direct influences, our findings show a positive (negative) long-run impact of the population and authority score (inflation) on economic growth, whereas the effect disappears in the short-run in the majority of the cases (see the parameter estimates θ_{pop}, $\theta_{\inf}$, θ_{reg}, ζ_{pop}, $\zeta_{\inf}$, ζ_{reg} in Table 2.2a, respectively). In addition, the parameter estimates show that the key findings for the indirect and direct (short- and long-run) impacts of domestic financial development on growth remain qualitatively unchanged (see parameter estimates ϕ_{fd} in Table 2.1a, θ_{fd} and ζ_{fd} in Table 2.2a). That is, there is a negative (positive) indirect and direct short-run (long-run) effect on economic growth.

To corroborate our analysis further we recalculate the parameters on $x_{i,t-1}$ in eq. (2.3) using a one step linear estimation (see for example Banerjee and Hendry, 1992, and Pinshi, 2020). Overall, our key findings for domestic financial development remain unchanged. The results are also robust to the inclusion of pop, inf and reg (see Tables 2.A.3 and 2.A.4 in the Appendix 1). Abreu and Verner (1997) by employing money supply as a measure of financial development argued that there is no evidence that financial development boosted growth. To investigate this further we re-run, for the period 1930 to 1993, the same PARCH regressions as with Tables 2.1a and 2.2a respectively, when the financial development measure is $m1$ and *bcc* (see Tables 2.A.4 and 2.A.5 in the Appendix 1). Our initial results on the effects of financial development (indirect and direct short- and long-run) on growth are confirmed even during this shorter period of time. More specifically we find (i) a negative indirect effect of both $m1$ and *bcc* on growth, whereas the direct effect of $m1$ and *bcc* is positive and (ii) a negative short-run effect of $m1$ on growth (the effect of *bcc* is statistically insignificant). The latter provides further evidence of the contribution of the PARCH effect compared to standard OLS estimates. Finally we explore to what extend data definitions change our conclusions. By running a methodology similar to that of Abreu and Verner (1997) for the period 1930-1993 (see Table 2.A.7 in the Appendix 1), but by utilizing *bcc* as an indicator of financial development (instead of money supply) we find a negative effect on growth though statistically insignificant (confirming our findings from Table 2.2).

2.5.2 Public vis-a-vis Private Banks

In a novel paper La Porta et al. (2002) argue that public ownership of banks has a negative impact on growth. According to their estimations a 10% increase in public ownership reduces annual growth of per capita gdp by 0.14-0.24%. The aforementioned study changed the view of the policy makers around the world on how they perceived public banks. Even the International Monetary Fund's recommendation is in favour of the privatisation of public banks in both developed and developing economies (see for more details Körner and Schnabel, 2010).

Our findings with respect to private and public banks are interesting and important. First we argue that the influence of private ownership (that is deposits in commercial banks) and public ownership (deposits at Bank of Brazil) on economic growth tends to be both direct and indirect. Interestingly, our parameter estimations highlight the significantly higher (in magnitude) negative indirect and direct short-run effects of public banks (compared to that of private banks) on growth. These results are robust to controlling for potential omitted variables biases (such as trade openness, government deficit, international financial development, population, inflation and authority score). The substantially higher (in absolute value: almost four and three times, respectively) negative effect of public bank ownership on growth highlights the extent to which the former affects the latter and the direction policy makers should take towards bank ownership, banking regulation and growth-enhancing policies in the case of Brazil.

Further decomposing these growth effects in their short- and long-run aspects is key. This is so not only because of the relatively large time window (historical series) but also because an important finding in the finance-growth nexus literature is that the effect of finance on growth tends to be positive in the

[15] We also considered certain factors such as the adverse physical geography (see Miguel et al., 2004 and Atsalakis et al., 2021) measured for instance by the variation in rainfall as well as the annual temperature, the human capital formation measured by the average years of education (see Spruk, 2016), the effect of culture on growth (see McCleary and Barro, 2006), the foreign direct investments (as well as their net inflows and net outflows), unemployment rate, central government debt as a share of gdp and the immigration rate, which potentially directly or indirectly affect economic growth. However, due to the historical scope of this paper (since 1870), these factors could not be included in our empirical estimations due to the unavailability of data.

long- but negative in the short-run. Our results for Brazil not only provide broad support for this finding, but also add a novel element to it, namely, that this asymmetry holds only for private (not for public) banks. We only find evidence of such a pattern (negative impact on growth in the short- and positive in the long-run) for private banks. This suggests that macro analysts and policy makers could anticipate (and subsequently review) the implications of their decisions on private bank ownership in both the short- and long-run, whereas for public banks these influences are restricted in the short-run. Table 2.3 reports a summary of our results.

2.5.3 Structural Breaks

Considering the role of structural changes, we adopt an important robustness test, that of the existence of structural breaks. We use the methodology developed by Bai and Perron (2003) to observe whether or not there are any structural breaks in growth as well as the main explanatory variables of our study, namely the financial development indicators.[16] For the economic growth series, we identify only one structural break, coinciding with the end of World War I, that is, for the year 1918. Interestingly, the financial development variables reveal different break dates. We estimate two breaks for the *m1* series, one in 1889 and another in 1930 (though statistically insignificant and hence omitted from the subsequent analysis), both reflecting massive changes in monetary policy following two important coups d'etat (1889 is the end of the Empire and the start of the Republic, whereas the one in 1930 marks the start of the "Estado Novo").

For both deposits at Bank of Brazil and at commercial banks there is one break before World War I (1911 and 1914 respectively) while only for the latter do we identify a second break in 1962. More specifically, the second break concerning private bank ownership takes place just before a major re-organization of the Brazilian financial system that culminated with the establishment of the Central Bank, after the military coup in March 1964. Although the Bai Perron (2003) test did not identify the breakpoints of 1929, 1980, and 2008 (where major economic crises took place), I incorporated them into the models presented in the equations 2.A.5 and 2.A.6 (in the Appendix 1) to evaluate their impact on Brazil's economic growth; however, the coefficients were statistically insignificant.

We find our results (regarding the effects of the domestic financial development) to be robust to the inclusion of the structural break dummies (see the Online Appendix for structural break modelling). Specifically, (i) it influences growth volatility negatively and (ii) there is a negative impact on growth in the short-run and a positive one in the long-run (only for the case of m1 and cbd) (see Tables 2.A.8 and 2.A.9, respectively).

Interestingly, the indirect and the direct short-run effects of m1 become weaker after the identified structural break in 1889, a result in line with the historical experience, (see Triner, 1996 and Goldsmith, 1986; and the $\varphi_{fd}^{(1)}$ column of Table 2.A.8, and the $\theta_{fd}^{(1)}$ column in Table 2.A.9, respectively). By the same token, i) the indirect effect of public bank ownership is stronger before the start of the Great War, 1911 (see the $\varphi_{fd}^{(1)}$ column of Table 2.A.8) and (ii) the indirect role of private bank ownership intensifies after 1962 (see the $\varphi_{fd}^{(2)}$ column of Table 2.A.8).

The breakpoint analysis corroborates our baseline results on the importance of public vs private bank ownership in the finance-growth nexus. From one side public banks play a more important indirect role (via volatility), whereas from the other private banks stimulate output growth in the long-run. One point worth mentioning is to look at the structural breaks in the estimated GARCH parameters. One way of moving forward could be the methodology introduced by Karanasos et al. (2021), Karanasos et al. (2022), Yfanti et al. (2023) and Canepa et al. (2023); see also Karanasos et al. (2023). Nevertheless, one potential limitation of the robustness of our results is that these papers use daily observations. To that extent, in our chapter we do not use breaks in the GARCH parameters because with annual observations we seek not to overparametrize our model.

2.5.4 Discussion

Our findings suggest that a better understanding of Brazilian growth patterns since the late 19th century may not only advance new policies but also promote the necessary political support for their

[16] For U.S. interest rate and, interestingly, for growth volatility we find no structural breaks. For trade openness and public deficit the breaks were statistically insignificant and are hence omitted from the models.

implementation. The importance of our findings lies in the fact that those proposals for deep reforms in Brazil will not win wide public acceptance if they are not perceived to respond to a credible account of how policies that are "wrong" in 2001 appeared "right" for half of the last century (see Pinheiro et al., 2004).

When policy reforms promote the development of a robust and stable financial system, financial services improve, accelerating economic growth, which in turn leads to reduced levels of extreme poverty on a sustainable basis.

Concluding, the predominant view in many developing and socialist countries was that state-owned financial institutions played an important role in reducing poverty. This was based on the idea that the private sector was not capable of supplying the necessary resources to crucial sectors of the economy. Nevertheless, despite their poor performance (which is confirmed by our results, that is a negative effect of public banks on growth), those institutions continued to dominate the financial sector. Our findings indicate that public ownership has generally proved to be inferior to private ownership perhaps for two reasons: (a) opportunistic behaviour on the part of politicians (the use of public institutions for personal political purposes) and (b) weak forms of corporate governance (for example poorly performing public institutions will eventually be bailed out, something that does not happen in the case of private ownership).

2.6 Conclusions and Future Research

Using a PARCH framework and data for Brazil from 1870 to 2018 we attempted to shed light on the following questions: What is the relationship between, on the one hand, financial development (domestic and international) and on the other hand, economic growth and (predicted) growth volatility? Are these effects fundamentally and systematically different? Does the intensity and the direction (the sign) of these effects vary over time, in general and, in particular, do they vary with respect to short- versus long-run considerations? Does ownership matter? We find that the main explanatory factors, solely in terms of their negative lagged indirect/direct (short-run) effects on economic growth in Brazil, turn out to be the domestic financial development indicators. Further, we find robust evidence that the U.S. interest rate affects growth positively both indirectly (via its volatility) and directly (both in the short- and long-run). Our results are robust to the inclusion of other economic variables i.e. trade openness and public deficit.

By observing a double negative effect (both direct and indirect) of domestic financial development on output growth the impact of the former on the latter is burdensome. Thus, macro theorists should incorporate the domestic financial development into their growth analysis.

We also find important differences in terms of the direct short-run and long-run behaviour of our key variables. More specifically, we argue that domestic financial development influences growth negatively in the short-run but positively in the long-run, whereas the impact of international financial integration is positive in both cases. Furthermore, the impact of private and public ownership on economic growth tends to be both direct and indirect. However, our parameter estimations highlight the significantly higher (in absolute magnitude) negative indirect and direct short-run effects of public banks (compared to those of private banks) on growth. Finally, trade openness and public deficit influence output growth negatively in the short-run. Our results are robust to the inclusion of population, inflation, and authority score as well as dummy variables.

The main goal of this study was to assess the role of domestic and international finance as well as that of public vs private bank ownership on Brazilian economic growth. Nevertheless, there are some limitations of the present study that should be addressed in subsequent studies. One such limitation is that the empirical evidence does not provide a definite account of the causal link between finance and growth since we do not exploit plausibly exogenous sources of variation in Brazil's long-run growth and do not use a research design that would allow us to exploit such channels. However, these concerns are greatly alleviated (with careful identification strategies and the lagged estimations or structural breaks) to the extent that our regressions yield consistent results. In addition, due to the historical scope of this chapter, certain factors such as the adverse physical geography measured, for instance, by the variation in rainfall as well as the annual temperature, the human capital formation measured by the average years of education, the effect of culture on growth, the foreign direct investment and the immigration rate, which potentially directly or indirectly affect economic growth, could not be considered due to the unavailability of data.

These findings are interesting but they also matter because they raise a number of new questions that we believe may be useful in motivating future research. Here we highlight two suggestions. Regarding the role of finance in the process of economic development, our findings reinforce a large body of previous research in that we also show a positive impact of financial development on growth in the long-run. We can not however underestimate the fact that Brazil is unique. Put differently, Brazil is an outlier and further research could try to replicate our analysis using the historical experience of other countries (ideally in a panel setting). That is, studying the relationship between financial development and economic growth in a panel of developing countries would strengthen what we know so far. Yet, the data requirements are very heavy indeed, with most developing countries lacking historical data even on key figures, such as the level of gdp, going back to the beginning or middle of the XIXth century. This, of course, does not make this task less important.

The second suggestion refers to a possible methodological improvement, namely the application of the smooth transition error correction model (see Jawadi et al., 2018 for alternative applications). This would clearly represent progress and is something we feel future research should try to address.

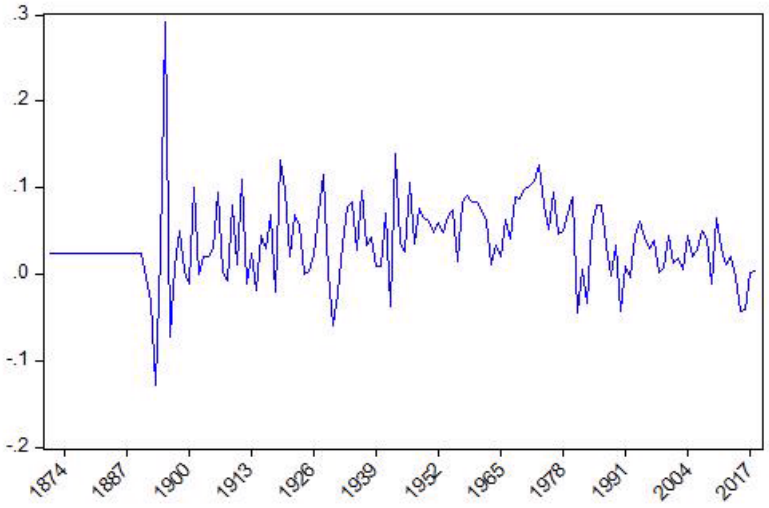


Figure 2.1 Growth Rate of Brazil GDP

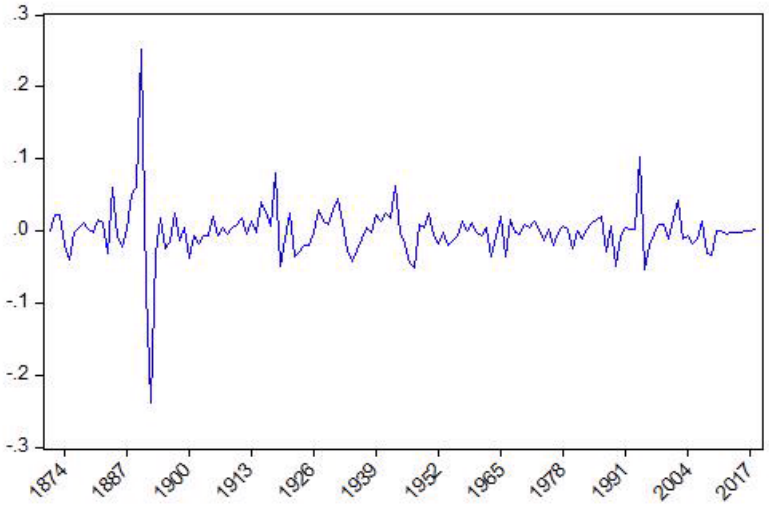


Figure 2.2 Commercial Bank Deposits over GDP (in First Difference)

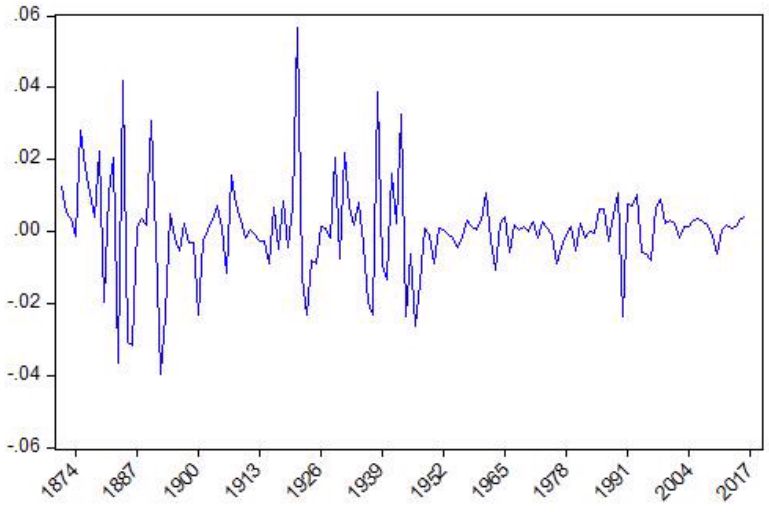


Figure 2.3 Deposits at Bank of Brazil over GDP (in First Difference)

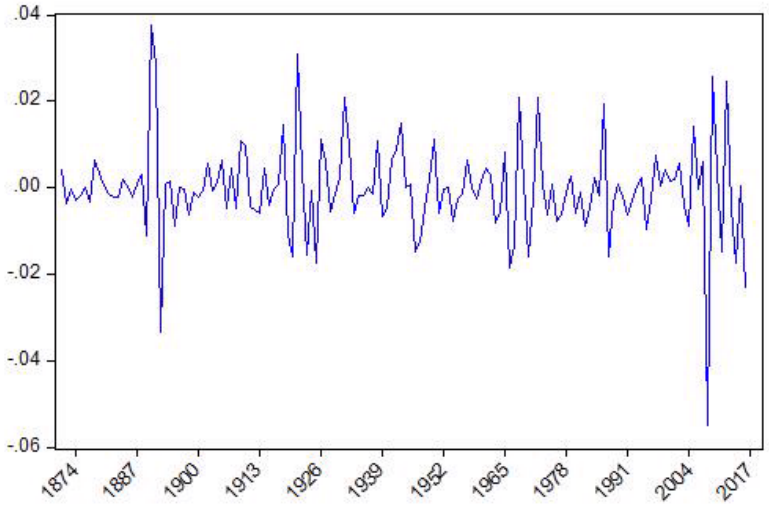


Figure 2.4 Money Supply (M1) over GDP (in First Difference)

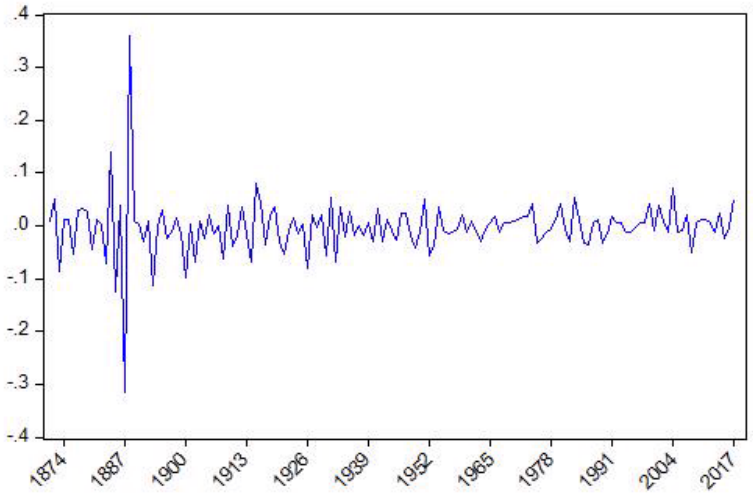


Figure 2.5 Trade Openness over GDP (in First Difference)

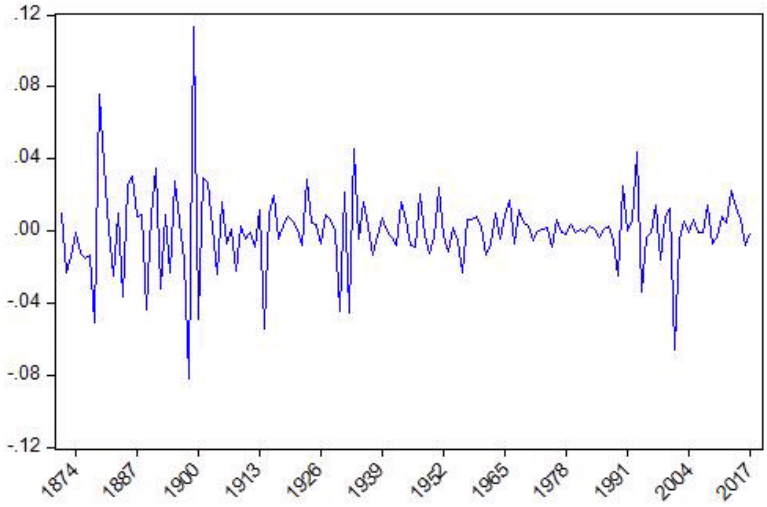


Figure 2.6 Public Deficit over GDP (in First Difference)

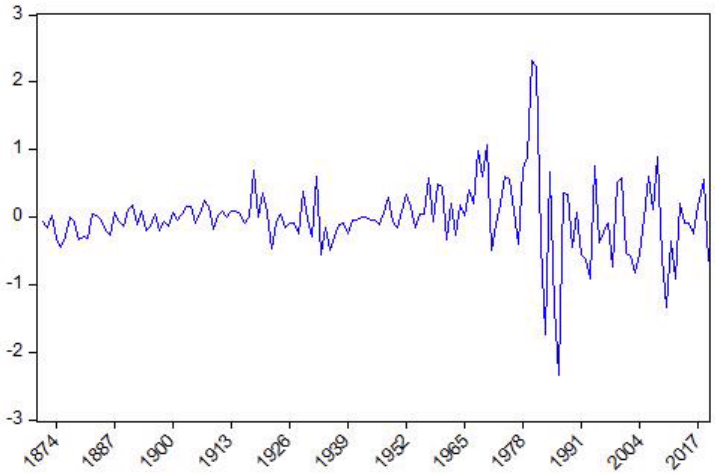


Figure 2.7 U.S. Interest Rate (in First Difference)

Table 2.1: Indirect Effects of Financial Development, Trade Openness, Public Deficit and US Interest Rate on Economic Growth

	k	ϕ_{fd}	ϕ_{to}	ϕ_{pd}	ϕ_{us}	α	β	γ	δ
m1	0.01	−0.21	−0.12	−0.11	0.01	0.40	0.36	0.12	1.00
	(4.69)	(−2.11) $_{l-6}$	(−2.84) $_{l-8}$	(−2.36) $_{l-3}$	(5.29) $_{l-1}$	(4.04)	(3.46)	(4.25) $_{n-8}$	
cbd	0.01	−0.09	−0.09	−0.14	0.01	0.40	0.39	0.13	1.00
	(7.25)	(−2.67) $_{l-8}$	(−1.70) $_{l-8}$	(−2.44) $_{l-3}$	(1.67) $_{l-8}$	(3.03)	(2.59)	(5.23) $_{n-8}$	
dbb	0.01	−0.37	−0.07	−0.08	0.01	0.46	0.41	0.15	1.00
	(2.06)	(−5.07) $_{l-5}$	(−6.31) $_{l-8}$	(−5.58) $_{l-3}$	(2.02) $_{l-6}$	(5.32)	(5.49)	(3.43) $_{n-8}$	
bcc	0.01	−0.01	−0.39	−0.76	0.02	0.54	0.31	0.14	0.70
	(8.72)	(−9.57) $_{l-2}$	(−2.18) $_{l-2}$	(−6.15) $_{l-5}$	(5.08) $_{l-8}$	(5.97)	(2.31)	(1.65) $_{n-8}$	

Table 2.1 reports parameter estimates of indirect effects for the following models:

$y_t = c + k\log(h_t) + \varepsilon_t,$

$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}} \mid e_{t-1} \mid^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}} + \sum_{i=fd,to,pd,us} \phi_i x_{i,t-l} + \gamma y_{t-n},$

$x_{fd,t-l}$ is either m1 or commercial bank deposits (cbd) or deposits at Bank of Brazil (dbb) or bank credit in all commercial banks (bcc)

$x_{to,t-l}$ is trade openness (to), $x_{pd,t-l}$ is public deficit (pd)

and $x_{us,t-l}$ is the U.S. interest rate (l and n are the order of the lags.

The numbers in parentheses are z statistics.

Table 2.2: The Direct Short- and Long-run Effects on Growth

	θ_{fd}	θ_{to}	θ_{pd}	θ_{us}	ζ_{fd}	ζ_{to}	ζ_{pd}	ζ_{us}	φ
m1	−0.23	−0.01	−0.13	0.01	0.24	0.01	0.05	0.01	−0.68
	(−1.68) $_{l-3}$	(−0.17) $_{l-5}$	(−2.09) $_{l-6}$	(3.04) $_{l-5}$	(2.66)	(0.73)	(1.62)	(2.74)	(−9.94)
cbd	−0.24	−0.04	−0.13	0.01	0.03	−0.01	0.01	0.01	−0.77
	(−4.49) $_{l-3}$	(−2.28) $_{l-2}$	(−4.60) $_{l-3}$	(2.08) $_{l-6}$	(7.71)	(−0.19)	(0.12)	(0.75)	(−8.77)
dbb	−0.76	−0.20	−0.15	0.01	−0.07	−0.03	0.03	0.01	−0.51
	(−2.66) $_{l-4}$	(−2.24) $_{l-5}$	(−1.03) $_{l-8}$	(1.20) $_{l-5}$	(−1.06)	(−1.42)	(0.41)	(2.91)	(−3.36)

Table 2.2 reports parameter (mean) estimates for the following model:

$\Delta y_t = \mu + \sum_{i=fd,topd,us} \theta_i \Delta x_{i,t-l} + \varphi(y_{t-1} - c - \sum_{i=fd,to,pd,us} \zeta x_{i,t-1}) + \varepsilon_t,$

$h_t^{\frac{\delta}{2}} = \omega + \alpha \left|u_{t-1}\right|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}.$

θ_i and ζ_i capture the direct short- and long-run effects respectively.

φ indicates the speed of adjustment to the long-run relationship.

$x_{i,t-l}$ can be the first difference of either financial development or trade openness or public deficit or U.S. interest rate. l and n are the order of the lags.

The short- and long-run impact of bcc is insignificant and hence omitted from the model.

The numbers in parentheses are z statistics.

Table 2.1a: Indirect Effects on Economic Growth - Robustness Check

	k	ϕ_{fd}	ϕ_{to}	ϕ_{pd}	ϕ_{us}	ϕ_{pop}	ϕ_{inf}	ϕ_{reg}	α	β	γ	δ
m1	0.01	−0.19	−0.14	−0.11	0.01	0.01	−0.01	0.01	0.46	0.37	0.16	1.00
	(8.79)	(−2.36) $_{l-6}$	(−7.05) $_{l-8}$	(−4.25) $_{l-3}$	(4.33) $_{l-1}$	(2.21) $_{l-2}$	(−0.85) $_{l-2}$	(3.47) $_{l-2}$	(4.96)	(4.34)	(7.20) $_{n-8}$	
cbd	0.01	−0.10	−0.14	−0.13	0.01	0.01	−0.01	0.01	0.35	0.40	0.20	0.90
	(3.63)	(−2.40) $_{l-8}$	(−1.61) $_{l-8}$	(−1.80) $_{l-3}$	(1.60) $_{l-8}$	(0.13) $_{l-2}$	(−2.11) $_{l-2}$	(2.64) $_{l-2}$	(2.91)	(2.78)	(5.53) $_{n-8}$	
dbb	0.01	−0.89	−0.25	−0.17	−0.01	0.01	−0.01	0.01	0.33	0.49	0.27	0.70
	(8.69)	(−5.45) $_{l-5}$	(−2.47) $_{l-8}$	(−1.82) $_{l-3}$	(−1.26) $_{l-6}$	(0.40) $_{l-1}$	(−1.67) $_{l-2}$	(2.33) $_{l-2}$	(4.01)	(5.33)	(4.62) $_{n-8}$	
bcc	0.01	−0.01	−0.30	−0.18	0.01	0.01	−0.01	0.01	0.23	0.44	0.24	0.80
	(6.14)	(−3.58) $_{l-6}$	(−4.37) $_{l-2}$	(−2.05) $_{l-6}$	(1.83) $_{l-6}$	(5.18) $_{l-1}$	(−2.87) $_{l-2}$	(4.19) $_{l-2}$	(2.58)	(3.12)	(3.31) $_{n-9}$	

Table 2.1a reports parameter estimates of indirect effects for the following models:

$$y_t = c + k\log(h_t) + \varepsilon_t,$$

$$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}} \mid e_{t-1} \mid^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}} + \sum_{i=fd,to,pd,us,pop,\text{inf},reg} \phi_i x_{i,t-l} + \gamma y_{t-n},$$

$x_{fd,t-l}$ is the first difference of either m1 or commercial bank deposits (cbd) or deposits at Bank of Brazil (dbb) or bank credit in all commercial banks (bcc), $x_{to,t-l}$ is trade openness (to), $x_{pd,t-l}$ is public deficit (pd), $x_{us,t-l}$ is the U.S. interest rate, $x_{pop,t-l}$ is the population (pop), $x_{\text{inf},t-l}$ is the inflation rate (inf) and $x_{reg,t-l}$ is the authority score (reg) and l and n are the order of the lags. The numbers in parentheses are z statistics.

Table 2.2a: The Direct Short- and Long-run Effects on Growth - Robustness Check

	θ_{fd}	θ_{to}	θ_{pd}	θ_{us}	θ_{pop}	$\theta_{\inf}$	θ_{reg}	ζ_{fd}	ζ_{to}	ζ_{pd}	ζ_{us}	ζ_{pop}	$\zeta_{\inf}$	ζ_{reg}	φ
m1	−0.36	−0.21	−0.23	0.01	0.01	−0.01	−0.01	0.23	0.01	−0.01	0.01	0.01	−0.01	0.01	−0.80
	(−1.98)	(−6.21)	(−2.75)	(1.68)	(1.71)	(−0.71)	(−0.01)	(1.88)	(1.54)	(−0.46)	(0.82)	(8.33)	(−2.05)	(4.92)	(−8.01)
	$l-3$	$l-5$	$l-6$	$l-4$	$l-2$	$l-2$	$l-2$								
cbd	−0.29	−0.07	−0.17	0.01	0.01	−0.01	−0.01	0.32	−0.01	−0.27	0.01	0.01	−0.01	0.01	−0.75
	(−2.70)	(−3.21)	(−2.68)	(2.45)	(1.30)	(−0.54)	(−0.57)	(1.68)	(−0.35)	(−2.15)	(0.52)	(3.51)	(−2.11)	(3.85)	(−7.88)
	$l-3$	$l-2$	$l-3$	$l-6$	$l-2$	$l-2$	$l-2$								
dbb	−0.51	−0.06	−0.02	0.01	0.01	0.01	−0.01	−0.04	−0.03	0.04	0.01	0.01	−0.01	0.01	−0.61
	(−3.51)	(−2.74)	(−0.17)	(0.06)	(0.66)	(0.14)	(−0.21)	(−1.28)	(−4.22)	(0.91)	(2.39)	(11.51)	(−2.55)	(6.18)	(−6.21)
	$l-4$	$l-5$	$l-8$	$l-4$	$l-2$	$l-2$	$l-2$								

Table 2.2a reports parameter (mean) estimates for the following model:

$$\Delta y_t = \mu + \sum_{i=fd,topd,us,pop,\inf,reg} \theta_i \Delta x_{i,t-l} + \varphi(y_{t-1} - c - \sum_{i=fd,to,pd,us,pop,\inf,reg} \zeta x_{i,t-1}) + \varepsilon_t,$$

$$h_t^{\frac{\delta}{2}} = \omega + \alpha \left|u_{t-1}\right|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}.$$

$\theta_i$and ζ_i capture the direct short- and long-run effects respectively. φ indicates the speed of adjustment to the long-run relationship. $x_{i,t-l}$ can be the first difference of either the financial development (fd) or trade openness (to) or public deficit (pd) or U.S. interest rate (us) or population (pop), or inflation rate (inf) or the authority score (reg). $l$and $n$are the order of the lags. The short- and long-run impact of bcc is insignificant and hence omitted from the model. The in parentheses are z statistics.

Table 2.3: Summary Results

	m1	cdb	dbb	us	to	pd
Indirect	−	−	−	+	−	−
Short-run (Direct)	−	−	−	+	−	−
Long-run (Direct)	+	+	0	+	0	0

Notes. −: negative; +: positive; 0: zero.

Appendix 1 for "The Finance-Growth Nexus and Public-Private Ownership of Banks in Brazil since 1870"

This supplementary material contains further background information about Brazil, graphical illustrations, our structural breaks methodology as well as tables with results.

Brief summary of our contribution

Our contribution in comparison to Abreu and Verner (1997) is as follows: (i) We use a very long period of time: 1870-2018, whereas they use a much shorter period of time: 1930-1993, (ii) we take into account PARCH effects, whereas they just use OLS regression, (iii) we examine not only the direct effects but the indirect as well, (iv) unlike their study we take into account structural breaks, (v) we distinguish between private and public banks, whereas they just use money supply and finally (vi) unlike their study we employ a bunch of covariates (i.e., trade openness, public deficit etc.). To

Brazilian background since 1870

This section aims mainly at providing background information about important economic eras in Brazilian history. This helps us examine the range of variables we want to focus on in the econometric analysis and evaluate our major estimation results.

Both economists and economic historians agree that the period 1870 to 1930 was one of growth, although Brazil suffered from World War I and the Great Depression. Then, for over a century, Brazil's economy would be dominated by the so-called Coffee Economic Cycle, or at least until 1930. Coffee boosted the Brazilian economy more than sugar or gold because Brazil was already free of colonial constraints when the coffee boom began. Besides, slavery ended in 1888, the beginning of a broad movement to wage labour. By the 1920s, Brazil provided over 80% of world coffee. But unlike Argentina, Brazilian international trade was closely tied to the United States, which imported most Brazilian coffee and was a major source of foreign cash. Trade openness contributed to 60% of GDP until 1900, and coffee exports were 12.5% of GDP by the 1920s. As Werner Baer (2001) and many other notable experts point out, coffee exports were the main engine of expansion for most of the 19th century. Brazil has had its independence since the early 19th century and built its first modern style financial system[17]; this emphasis on the role of the financial system is not a key part of this literature, and we wish to contribute to it. This chapter thus poses the central question whether this combination of financial development and other factors has influenced Brazil's output growth.

The First Republic

The period from 1889 to 1930 is called the Old Republic or the First Republic and is distinguished economically by the politics of coffee-with-milk ("cafe com leite") between Sao Paulo and Minas Gerais political elites. The political situation in Brazil rarely remained steady during this time period. The tenente revolts of 1922 and 1924 rattled Brazil's interior but the army never seized it. Next came the economic crisis which affected the Old republic greatly. In October 1929 the Great Depression cut profits from coffee exports and the Paulista elite attempted to keep power in the republic without observing the Minas Gerais alternation. That ended the "politics of coffee with milk." The situation worsened in 1930. Together with all these political crises came the economic crisis which brought down the Old Republic on 24 October 1930. During the 1930s through the late 1970s, economic historians say, Brazil had one of the world's fastest growing economies. While most agree the 1980s were a "lost decade" economically (but it saw redemocratization), Brazil's rise after 1990 is drawing a lot of attention now.

There are three main periods where financial development affected economic growth significantly. The first of the three periods is known as the Milagre Economico (Economic Miracle), when average yearly growth rates were extraordinarily high following a number of key financial sector reforms that facilitated a substantial rise in infrastructure investment, Goldsmith (1986).

The second phase of the positive effect of financial development on economic expansion took place between 1991 and 1993. Possible explanations for this positive relationship are initiatives from the early

[17] For instance, Banco do Brasil was created in 1808 and functioned both as a commercial bank as well as a bank of issue 1829.

1990s aimed at identifying non-inflationary financing sources and reducing foreign savings in Brazil. Notably, though political turmoil of the early 1990s ensued, legislative amendments in 1991 allowed foreigners to trade in domestically issued bonds and securities, Studart (2000). From 1992, capital flows increased as capital that had left in the 1980s was repatriated due to 1979 interest rate shocks.

The third and final period covers the late 1990s. This could be attributed to the 1994 Real Plan success and the 1997 extension of PROER, which triggered a surge in mergers and acquisitions in the financial sector (see Folkerts-Landau et al., 1997). Also, new financial institutions entering the Brazilian market have allowed financial sector deregulation, as documented in Bittencourt (2011).

International Comparison of Per Capita GDP

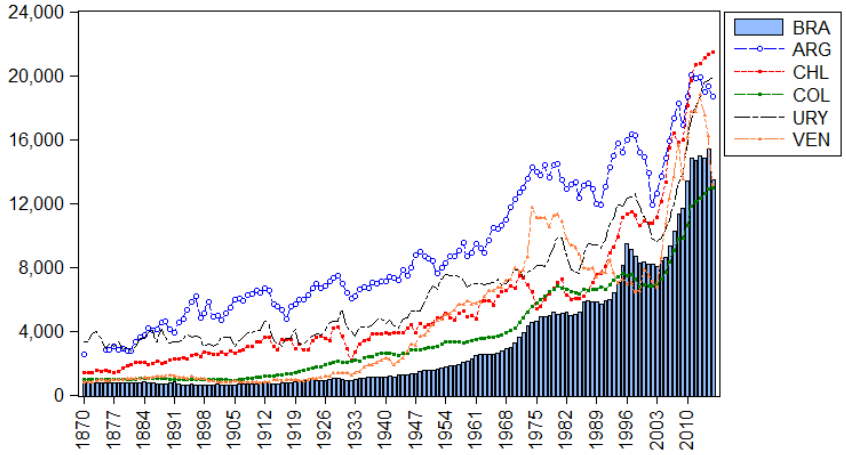


Figure 2.A1.a: Per Capita GDP — Brazil vs Latin American Countries

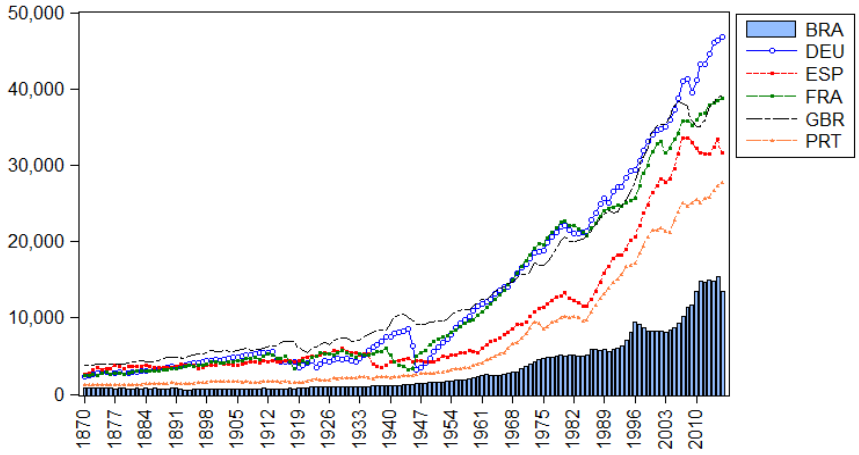


Figure 2.A1.b: Per Capita GDP — Brazil vs Western European Countries

Sample Autocorrelations, Wald and Akaike (AIC) Statistics

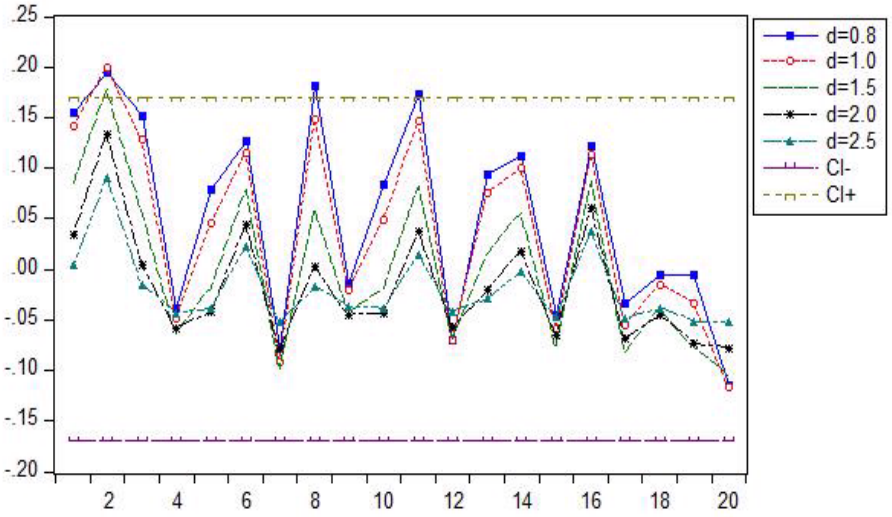


Figure 2.A2: Autocorrelation of $\mid y_t \mid^d$ from High to Low.

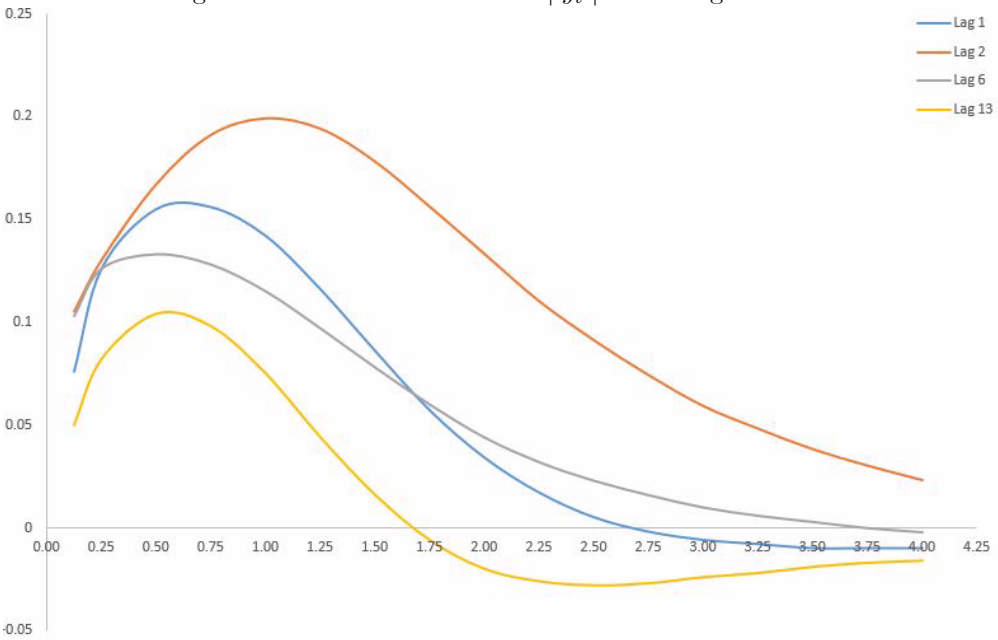


Figure 2.A3: Autocorrelation of $\mid y_t \mid^d$ at Lag 1,2, 6 and 13

Table 2.A.1 Heteroscedasticity Tests

Variable	p-value of ARCH test
gdp	0.015
cbd	0.007
dbb	0.017
m1	0.006
us	0.001
to	0.001
pd	0.001

Table 2.A.1 reports the p-values of the ARCH tests. All results indicate rejection of the null hypothesis of homoscedasticity in the squared residuals.

Table 2.A.2: Wald Tests - $\chi^2(1)$ and AIC

Panel A – Tests for Restrictions on Power Term Parameters				
H_0:	$\delta = 1$	$\delta = 2$		
GDP Growth	16.35[0.01]	27.39[0.00]		
	Panel B – AIC			
Direct Effect of Financial Development on Growth	$\delta = 0.7$	$\delta = 0.9$	$\delta = 1.0$	$\delta = 2.0$
m1	−3.56		−3.52	−3.53
cbd	−3.53		−3.55	−3.49
dbb		−3.60	−3.58	−3.57

Panel A reports the value of the Wald statistic of the restricted PARCH(1,1) when $\delta = 1$ and $\delta = 2$. The number in square brackets is p-value. Panel B reports the Akaike Information Criterion (AIC) for each of the restricted PARCH(1,1) in the case of the direct effect of financial development on growth when $\delta = 0.7, 0.9, 1$ and 2.

Aternative Calculation of Direct Short- and Long-Run Impacts on Growth - One Step

Next, we recalculate the parameters on $x_{i,t-1}$ in eq. (2.3) using a one step linear estimation. More specifically, to calculate the direct short- and long-run associations we utilize the below error correction (P)ARCH form:

$$\Delta y_t = \mu + \sum_{i=fd,to,pd,us} \theta_i \Delta x_{i,t-l} + \varphi y_{t-1} + \sum_{i=fd,to,pd,us} \zeta_i x_{i,t-1} + \varepsilon_t, \tag{2.A.1}$$

where the short-run parameters are as before θ_i, but the new long-run parameters are: $\frac{\varphi}{-\zeta_i}$ (we recall that x_{it} denotes the first difference of the explanatory variable). The lag of the second difference of either the financial development (domestic or international) or trade openness or public deficit ($\Delta x_{i,t-l}$) characterizes the direct short-run effect.

We also take into account the PARCH effects by specifying the error term ε_t as follows:

$$\varepsilon_t = e_t h_t^{\frac{1}{2}}, \tag{2.A.2}$$

where

$$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}} |e_{t-1}|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}. \tag{2.A.3}$$

Our parameter estimates are summarized in Table 2.A.3 below. More specifically, they show that the key findings for the direct (short- and long-run) impacts of domestic financial development on growth remain qualitatively unchanged (see parameter estimates θ_{fd} and ζ_{fd} respectively). That is, there is a negative (positive) short- (long-) run direct effect on economic growth. These results are robust to the inclusion of pop, inf and reg (see parameter estimates θ_{fd} and ζ_{fd} in Table 2.A.4, respectively).

Table 2.A.3: The Direct Short- and Long-run Effects on Growth - One Step

	θ_{fd}	θ_{to}	θ_{pd}	θ_{us}	ζ_{fd}	ζ_{to}	ζ_{pd}	ζ_{us}	φ
m1	-0.28	-0.01	-0.08	0.01	0.75	-0.02	-0.01	0.01	-0.64
	(-1.84)	(-0.57)	(-1.93)	(1.68)	(5.48)	(-1.01)	(-0.17)	(0.55)	(-12.16)
	$l-6$	$l-6$	$l-6$	$l-5$	$l-1$	$l-1$	$l-1$	$l-1$	
cbd	-0.06	-0.06	-0.06	0.01	0.12	-0.05	-0.01	0.01	-0.62
	(-1.69)	(-3.85)	(-2.88)	(2.54)	(2.13)	(-2.12)	(-0.18)	(0.12)	(-12.24)
	$l-6$	$l-2$	$l-3$	$l-6$	$l-1$	$l-1$	$l-1$	$l-1$	
dbb	-0.31	0.01	-0.25	0.01	0.67	-0.05	-0.07	0.01	-0.57
	(-2.83)	(0.14)	(-4.08)	(2.49)	(4.88)	(-1.56)	(-0.75)	(0.83)	(-8.92)
	$l-4$	$l-5$	$l-6$	$l-5$	$l-1$	$l-1$	$l-1$	$l-1$	

Table 2.A.3 reports parameter (mean) estimates for the following model:

$$\Delta y_t = \mu + \sum_{i=fd,topd,us} \theta_i \Delta x_{i,t-l} + \varphi y_{t-1} + \sum_{i=fd,to,pd,us} \zeta x_{i,t-1} + \varepsilon_t,$$

$$h_t^{\frac{\delta}{2}} = \omega + \alpha \left| u_{t-1} \right|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}.$$

θ_i captures the direct short-run whereas $\frac{\varphi}{-\zeta_i}$ the firect long-run effects respectively.

$x_{i,t-l}$ can be the first difference of either financial development or trade openness or public deficit or U.S. interest rate. l and n are the order of the lags.

The short- and long-run impact of bcc is insignificant and hence is omitted from the model.

The numbers in parentheses are z statistics.

Table 2.A.4: The Direct Short- and Long-run Effects on Growth - Robustness Check - One Step

	θ_{fd}	θ_{to}	θ_{pd}	θ_{us}	θ_{pop}	$\theta_{\inf}$	θ_{reg}	ζ_{fd}	ζ_{to}	ζ_{pd}	ζ_{us}	ζ_{pop}	$\zeta_{\inf}$	ζ_{reg}	φ
m1	−0.28	0.02	−0.14	0.01	0.01	0.02	0.01	0.77	0.03	−0.10	−0.01	0.01	−0.01	0.01	−0.61
	(−3.05)	(0.39)	(−4.02)	(1.73)	(1.74)	(0.72)	(1.09)	(5.54)	(1.73)	(−1.59)	(−0.34)	(1.47)	(−1.19)	(0.17)	(−12.27)
	$l-6$	$l-6$	$l-6$	$l-5$	$l-2$	$l-2$	$l-2$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	
cbd	−0.32	−0.02	−0.21	0.01	0.01	−0.01	−0.01	0.39	−0.05	−0.06	−0.01	0.01	−0.01	0.01	−0.79
	(−2.04)	(−0.26)	(−2.70)	(1.20)	(1.11)	(−1.02)	(−0.57)	(2.30)	(−0.59)	(−0.76)	(−0.05)	(1.81)	(−0.83)	(2.11)	(−11.05)
	$l-3$	$l-2$	$l-3$	$l-6$	$l-2$	$l-2$	$l-2$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	
dbb	−0.43	0.01	−0.22	0.01	0.01	0.01	0.01	0.60	−0.06	−0.08	0.01	0.01	−0.01	0.01	−0.62
	(−2.94)	(0.12)	(−3.46)	(2.96)	(3.48)	(0.20)	(1.60)	(4.32)	(−1.78)	(−0.78)	(0.75)	(0.83)	(−1.72)	(0.73)	(−8.58)
	$l-4$	$l-5$	$l-6$	$l-5$	$l-2$	$l-2$	$l-2$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	$l-1$	

Table 2.A.4 reports parameter (mean) estimates for the following model:

$$\Delta y_t = \mu + \sum_{i=fd,topd,us,pop,\inf,reg} \theta_i \Delta x_{i,t-l} + \varphi y_{t-1} + \sum_{i=fd,to,pd,us,pop,\inf,reg} \zeta x_{i,t-1} + \varepsilon_t,$$

$$h_t^{\frac{\delta}{2}} = \omega + \alpha \left|u_{t-1}\right|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}.$$

θ_i captures the direct short-run whereas $\frac{\varphi}{-\zeta_i}$ the direct long-run effects respectively. $x_{i,t-l}$ can be the first difference of either financial development (fd) or trade openness (to) or public deficit (pd) or U.S. interest rate (us) or population (pop), or inflation rate (inf) or the authority score (reg). l and n are the order of the lags. The short- and long-run impact of bcc is insignificant and hence is omitted from the model. The in parentheses are z statistics.

Table 2.A.5: Indirect Effects on Economic Growth - Robustness Check - Time Period 1930-1993

	k	ϕ_{fd}	ϕ_{to}	ϕ_{pd}	ϕ_{us}	ϕ_{pop}	ϕ_{inf}	ϕ_{reg}	α	β	γ	δ
m1	0.02	−0.47	−0.24	−0.41	0.01				0.10	0.62	0.12	1.00
	(2.51)	(−3.32)	(−3.62)	(−6.20)	(6.55)				(3.11)	(13.38)	(5.79)	
		$l-6$	$l-4$	$l-3$	$l-1$						$n-8$	
m1	0.01	−0.56	−0.34	−0.19	0.01	0.02	0.01	0.01	0.18	0.44	0.03	1.00
	(6.16)	(−2.68)	(−4.88)	(−2.74)	(5.20)	(1.95)	(−0.61)	(4.18)	(1.67)	(4.04)	(1.80)	
		$l-6$	$l-8$	$l-3$	$l-1$	$l-1$	$l-2$	$l-1$			$n-8$	
bcc	0.01	−0.10	−0.35	−0.23	0.01				0.28	0.66	0.22	0.70
	(2.73)	(−2.31)	(−2.66)	(−0.49)	(2.18)				(2.16)	(4.78)	(1.80)	
		$l-3$	$l-6$	$l-6$	$l-4$						$n-8$	
bcc	0.03	−0.01	−0.01	−0.34	0.01	0.01	−0.01	0.01	0.18	0.28	0.10	0.80
	(7.17)	(−2.37)	(−0.06)	(−3.10)	(1.18)	(13.15)	(−0.68)	(1.81)	(1.87)	(2.79)	(2.60)	
		$l-6$	$l-2$	$l-6$	$l-6$	$l-6$	$l-2$	$l-5$			$n-7$	

Table 2.A.5 reports parameter estimates of indirect effects for the following models:

$$y_t = c + k\log(h_t) + \varepsilon_t,$$

$$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}} \mid e_{t-1} \mid^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}} + \sum_{i=fd,to,pd,us,pop,\text{inf},reg} \phi_i x_{i,t-l} + \gamma y_{t-n},$$

$x_{fd,t-l}$ is the first difference of m1 or bank credit,

$x_{to,t-l}$ is trade openness (to), $x_{pd,t-l}$ is public deficit (pd), $x_{us,t-l}$ is

the U.S. interest rate, $x_{pop,t-l}$ is the population (pop), $x_{\text{inf},t-l}$ is the inflation rate (inf) and $x_{reg,t-l}$ is the authority score (reg) and l and n are the order of the lags. The numbers in parentheses are z statistics.

Table 2.A.6: The Direct Short- and Long-run Effects on Growth Time Period 1930-1993

	θ_{fd}	θ_{to}	θ_{pd}	θ_{us}	θ_{pop}	$\theta_{\inf}$	θ_{reg}	ζ_{fd}	ζ_{to}	ζ_{pd}	ζ_{us}	ζ_{pop}	$\zeta_{\inf}$	ζ_{reg}	φ
m1	−0.51	0.07	−0.35	0.01	0.01	−0.01	0.01	0.75	0.24	0.10	0.01	0.01	−0.01	0.01	−0.76
	(−1.78)	(0.82)	(−2.29)	(4.96)	(0.03)	(−1.28)	(0.69)	(1.92)	(0.91)	(0.19)	(1.93)	(2.88)	(−2.26)	(3.55)	(−7.72)
	$l-3$	$l-2$	$l-4$	$l-2$	$l-2$	$l-2$	$l-2$								
bcc	−0.01	0.18	−0.79	0.01	0.01	−0.01	0.01	0.01	−0.05	0.33	0.02	0.01	0.01	−0.01	−0.48
	(−0.38)	(0.94)	(0.06)	(3.93)	(0.03)	(−0.52)	(0.69)	(4.39)	(−0.25)	(0.63)	(1.76)	(3.63)	(8.28)	(2.49)	(−2.79)
	$l-6$	$l-6$	$l-4$	$l-3$	$l-1$	$l-2$	$l-1$								

Table 2.A.6 reports parameter (mean) estimates for the following model:

$$\Delta y_t = \mu + \sum_{i=fd,to,pd,us,pop,\inf,reg} \theta_i \Delta x_{i,t-l} + \varphi(y_{t-1} - c - \sum_{i=fd,to,pd,us,pop,\inf,reg} \zeta x_{i,t-1}) + \varepsilon_t,$$

$$h_t^{\frac{\delta}{2}} = \omega + \alpha \left|u_{t-1}\right|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}.$$

θ_i and ζ_i capture the direct short- and long-run effects respectively. φ indicates the speed of adjustment to the long-run relationship. $x_{i,t-l}$ can be the first difference of either financial development or trade openness public deficit or U.S. interest rate or population or inflation rate or authority score. l is the order of the lags.

The numbers in parentheses are z statistics.

Table 2.A.7: OLS Estimates for Bank Credit (bcc)
Time Period 1930-1993

	ψ_{fd}	ψ_{to}	ψ_{pd}	ψ_{us}	ψ_{pop}	$\psi_{\inf}$	ψ_{reg}
dbb	-0.01	-0.10	-0.56	0.01	-0.01	-0.01	0.01
	(-0.86)	(-0.42)	(-1.06)	(1.11)	(-0.29)	$(-2/73)$	(0.73)
	$_{l-5}$	$_{l-8}$	$_{l-2}$	$_{l-4}$	$_{l-2}$	$_{l-1}$	$_{l-2}$

Table 2.A.7 provied the parameters for the following model:

$$y_t = \alpha + \sum_{i=fd,to,pd,us,pop,\inf,reg} \psi x_{i,t-1} + \varepsilon_t,$$

y_t is the growth and ψ captures the effects of the set of explanatory variables (a is the constant). $x_{i,t-l}$ can be either financial development or trade openness or public deficit or U.S. interest rate, or population or inflation or the authority score. l is the order of the lags.
The numbers in parentheses are z statistics.

Structural Breaks Methodology

In this part, we include dummy variables in equations (2.2) (indirect impact) and (2.3) (short- and long-run direct effects), therefore considering breakpoints in growth and financial development under the Bai-Perron framework. Initially, we introduce the subsequent notation. D_t, is a (intercept) dummy defined as: $D_t = 1$ in the period 1918-2018 and $D_t = 0$ otherwise. Similarly, $D_{it}^{(j)}$, $j = 1, 2$, is a slope dummy representing the time commencing from the year of the break in the first difference of either the financial development or trade openness or public deficit or U.S. interest rate variable (x_{it}), and $D_{it}^{(j)} = 0$ otherwise. For example for the deposits at bank of Brazil $D_{it}^{(1)} = 1$ is the period from 1914 to 2018. The augmented model, that captures the indirect effects, is given by

$$y_t = c + k \log(h_t) + \epsilon_t, \tag{2.A.4}$$

and

$$h_t^{\frac{\delta}{2}} = \omega + \omega_1 D_t + \alpha h_{t-1}^{\frac{\delta}{2}} f\left(e_{t-1}\right) + \beta h_{t-1}^{\frac{\delta}{2}} + \sum_{i=fd,to,pd,us} \left(\phi_i x_{i,t-l} + \phi_i^{(1)} D_{i,t-l}^{(1)} x_{i,t-l} + \phi_i^{(2)} D_{i,t-l}^{(2)} x_{i,t-l}\right) + \gamma y_{t-n}. \tag{2.A.5}$$

Most importantly, the coefficients ϕ_i capture the effects of the control variables on volatility. Similarly, $\phi_i^{(j)}$ represent the effects from the year of the break and onwards. Therefore, ϕ_i record the impacts up to the year of the structural break, while $\phi_i + \phi_i^{(j)}$ capture the impacts from the year of the break until the end of the sample. As in our baseline results we study the indirect effects of our set of explanatory variables on growth by estimating equations (2.A.4-2.A.5) above.

In the error correction formula (2.3) we also include level effects and intercept dummies, as follows:

$$\Delta y_t = \mu + \sum_{i=fd,to,pd,us} \left(\theta_i \Delta x_{i,t-l} + \theta_i^{(1)} D_{i,t-l} \Delta x_{i,t-l}\right) + \varphi(y_{t-1} - c - \sum_{i=fd,to,pd,us} \zeta_i x_{i,t-1}) + \varepsilon_t. \tag{2.A.6}$$

Structural Breaks Tables of Results

Table 2.A.8 Indirect Effects of Financial Development, Trade Openness, Public Deficit and US Interest Rate on Economic Growth With Dummies

	k	ϕ_{fd}	$\phi_{fd}^{(1)}$	$\phi_{fd}^{(2)}$	ϕ_{to}	ϕ_{pd}	ϕ_{us}	α	β	γ	δ
m1	0.01	−0.26	0.16	–	−0.13	−0.14	0.01	0.42	0.35	0.15	0.90
	(5.50)	(−1.99) $_{l-6}$	(1.80) $_{l-4}$		(−1.81) $_{l-8}$	(−2.08) $_{l-3}$	(6.87) $_{l-1}$	(5.23)	(5.28)	(4.11) $_{n-8}$	
cbd	0.01	−0.09	0.11	−0.18	−0.11	−0.21	0.01	0.36	0.34	0.12	0.90
	(3.33)	(−1.96) $_{l-8}$	(1.94) $_{l-6}$	(−3.79) $_{l-7}$	(−1.18) $_{l-8}$	(−2.76) $_{l-3}$	(1.08) $_{l-8}$	(2.98)	(2.37)	(1.94) $_{n-8}$	
dbb	0.01	−0.26	0.21	–	−0.09	−0.08	0.01	0.44	0.43	0.11	1.00
	(7.25)	(−4.40) $_{l-5}$	(2.90) $_{l-8}$		(−1.89) $_{l-8}$	(−2.20) $_{l-3}$	(1.86) $_{l-6}$	(4.40)	(4.74)	(4.11) $_{n-8}$	

Table 2.A.8 reports parameter estimates of indirect effects for the following models:
$y_t = c + k \log(h_t) + \varepsilon_t$,
$h_t^{\frac{\delta}{2}} = \omega + \alpha h_{t-1}^{\frac{\delta}{2}} \mid e_{t-1} \mid^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}} + \sum_{i=fd,to,pd,us} \Big(\phi_i x_{i,t-l} + \phi_{fd}^{(1)} D_{fd,t-l}^{(1)} x_{fd,t-l}$
$+ \phi_{fd}^{(2)} D_{fd,t-l}^{(2)} x_{fd,t-l}\Big)$.
$D_{fd,t-l}^{(1)}$ is a slope dummy defined as 1 in the period: 1889-2018 (for m1); 1914-2016 (for commercial bank deposits) and 1911-2018 (for deposits at Bank of Brazil); and 0 otherwise.
$D_{fd,t-l}^{(2)} = 1$ in the period 1962-2003 (for commercial bank deposits) and 0 otherwise. $x_{fd,t-l}$ is either *m1* or *cbd* or *dbb*. $x_{to,t-l}$ is to, $x_{pd,t-l}$ is *pd*.and $x_{us,t-l}$ is *us*.
l and n are the order of the lags.
The numbers in parentheses are z statistics.

Table 2.A.9 The Direct Short- and Long-run Effects on Growth With Dummies

	θ_{fd}	$\theta_{fd}^{(1)}$	θ_{to}	θ_{pd}	θ_{us}	ζ_{fd}	ζ_{to}	ζ_{pd}	ζ_{us}	φ
m1	−0.35	0.32	−0.23	−0.32	0.01	0.24	0.01	0.05	0.01	−0.68
	(−1.72)	(1.68)	(−2.51)	(−4.06)	(2.45)	(27.38)	(0.73)	(1.62)	(2.74)	(−9.94)
	$l-6$	$l-8$	$l-5$	$l-6$	$l-6$					
cbd	−0.28	−0.02	−0.05	−0.15	0.01	0.03	−0.01	0.01	0.01	−0.77
	(−2.56)	(−0.41)	(−2.34)	(−4.45)	(2.95)	(7.71)	(−0.19)	(0.12)	(0.75)	(−8.77)
	$l-3$	$l-7$	$l-2$	$l-3$	$l-6$					
dbb	−0.65	−0.05	−0.24	−0.11	0.01	−0.07	−0.03	0.03	0.01	−0.51
	(−3.94)	(−0.30)	(−2.29)	(−0.99)	(−0.41)	(−1.06)	(−1.42)	(0.41)	(2.91)	(−3.36)
	$l-4$	$l-1$	$l-5$	$l-8$	$l-5$					

Table 2.A.9 reports parameter (mean) estimates for the following model:

$$\Delta y_t = \mu + \sum_{i-fd,to,pd,us} \left(\theta_i \Delta x_{i,t-l} + \theta_i^{(d)} D_{i,t-l} \Delta x_{i,t-l}\right) + \varphi(y_{t-1} - c - \sum_{i=fd,to,pd,us} \zeta x_{i,t-1}) + \varepsilon_t,$$

$h_t^{\frac{\delta}{2}} = \omega + \alpha \left|u_{t-1}\right|^{\delta} + \beta h_{t-1}^{\frac{\delta}{2}}$.

θ_i and ζ_i capture the short- and long-run effects respectively.

$D_{i,t-l}$ is a slope dummy defined as 1 in the period 1889-2018 (for m1); 1914-2016

(for commercial bank deposits) and 1911-2018 (for deposits at Bank of Brazil);

φ indicates the speed of adjustment to the long-run relationship.

$x_{i,t-l}$ can be either financial development or trade openness or public deficit or U.S. interest rate.

l and n are the order of the lags.

The numbers in parentheses are z statistics.

Graphs for Data at Level

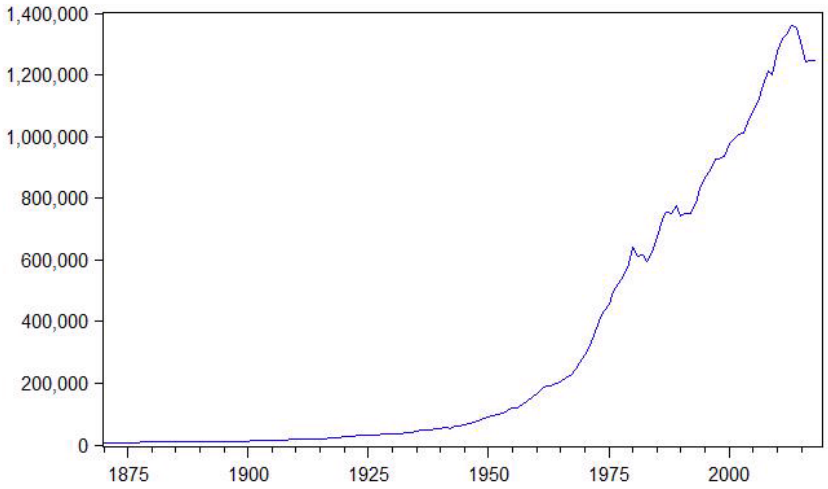


Figure 2.8: Gross Domestic Product (GDP) Brazil

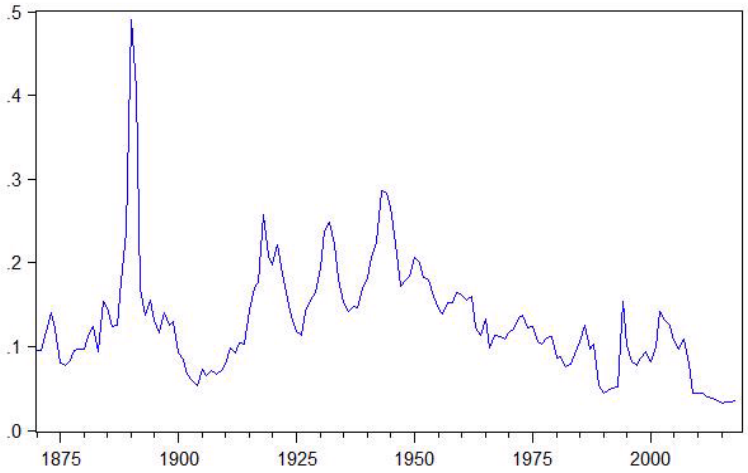


Figure 2.9: Commercial Bank Deposits over GDP

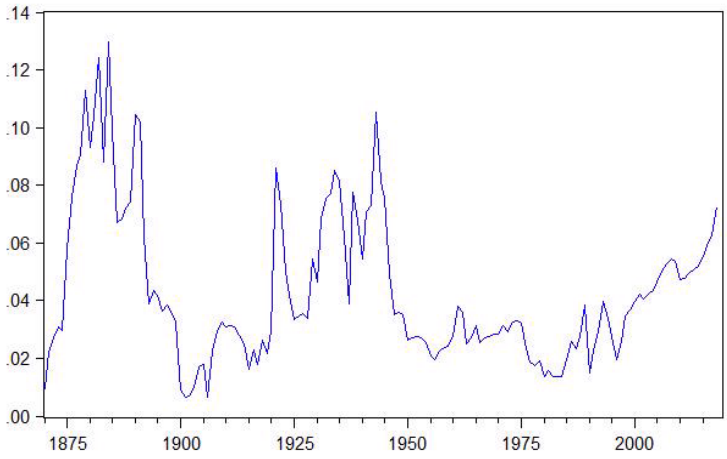


Figure 2.10: Deposits at Bank of Brazil over GDP

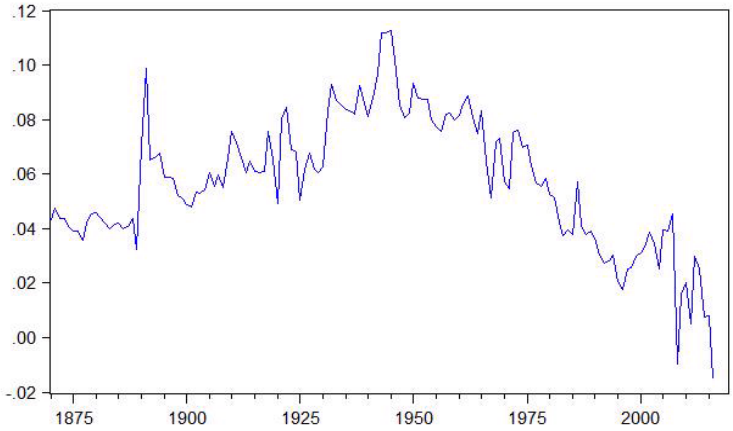


Figure 2.11: Money Supply (M1) over GDP

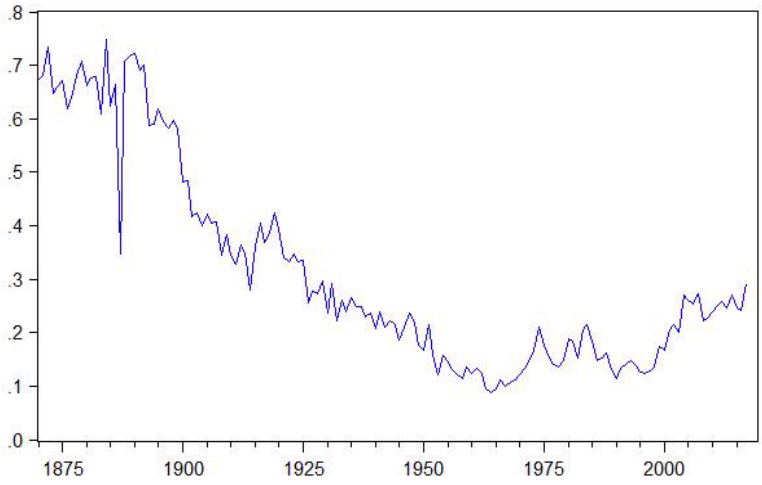


Figure 2.12: Trade Openness over GDP

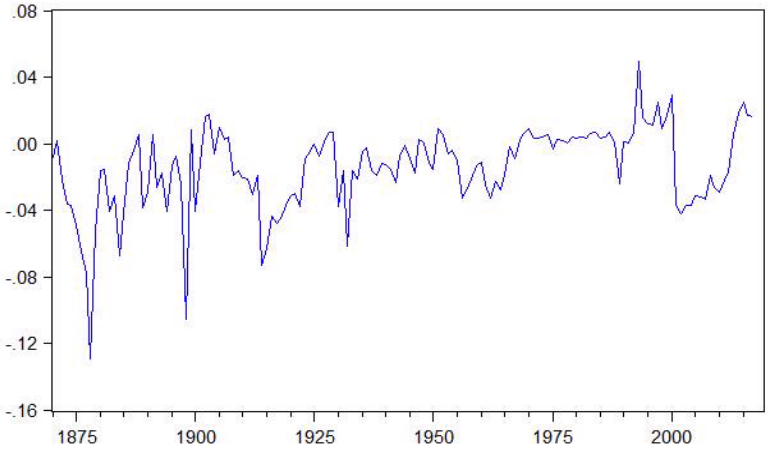


Figure 2.13: Public Deficit over GDP

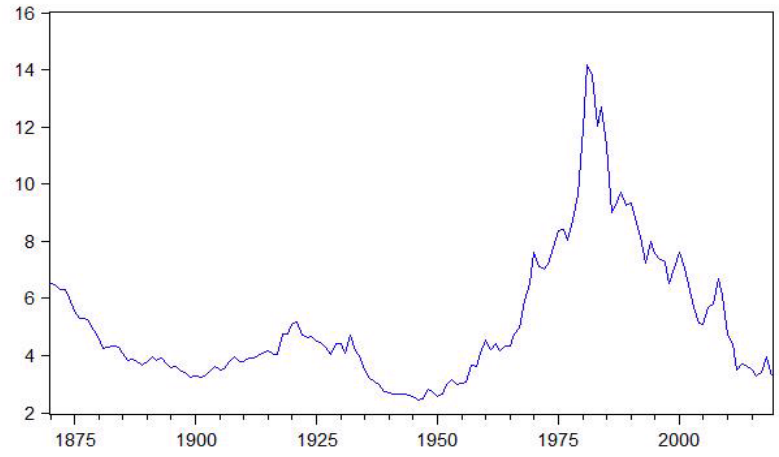


Figure 2.14: U.S. Interest Rate

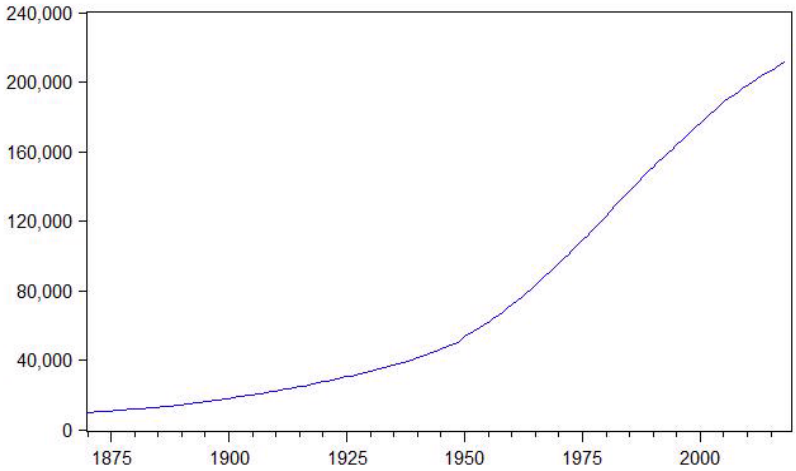


Figure 2.15: Population of Brazil, in Thousands

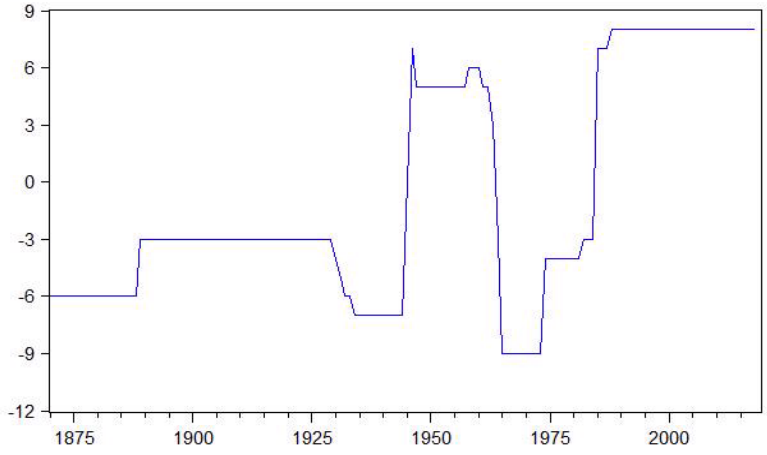


Figure 2.16: Authority Score

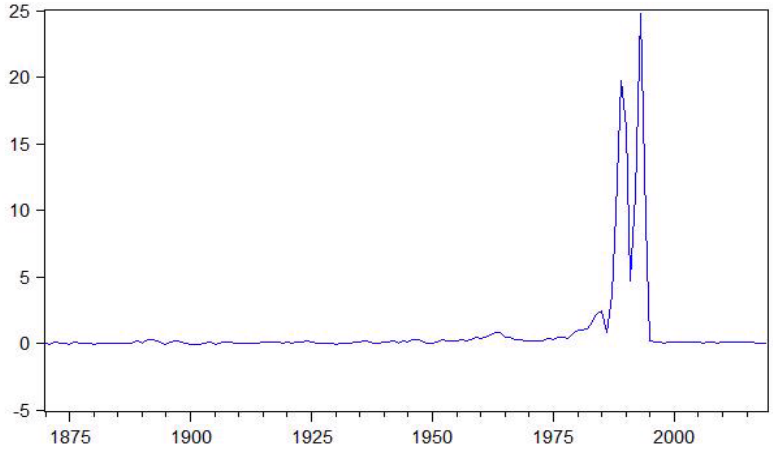


Figure 2.17: Inflation Rate

Data Definitions and Sources

Table 2.B Data Definitions and Sources

Acronym	Definition	Source
gdp	The growth rate of gross domestic product at level	Mitchell (2003), FRED
bcc	The growth rate of bank credit in all commercial banks in Brazil	FRED
cbd	The sum of time deposits and deposits (other than time deposits) at the end of the period in commercial banks over gdp	Mitchell (2003), FRED
dbb	The sum of time deposits and deposits (other than time deposits) at the end of the period in central bank over gdp	Mitchell (2003), FRED
m1	Money supply 1 as a share of gdp	Mitchell (2003), FRED
us	The level of interest rate in the U.S.	Friedman and Schwartz (1982), FRED
to	Trade openness, is the ratio of imports plus exports to gdp	Mitchell (2003), IBGE
pd	Public deficit, measured as the ratio of total public deficit to gdp	Mitchell (2003), IBGE
pop	Population in Brazil	Maddison Project
inf	Inflation rate in Brazil	Global Financial Data
reg	Computed by substracting the autocracy from the democracy score	Polity Project

Table 2.B reports the data definitions and the data sources of the raw data used in our regression analysis.

Chapter 3

Financial Development, Political Instability, Trade Openness and Growth in Brazil: Evidence from a New Dataset, 1890-2003

3.1 Introduction

In 2001, Goldman Sachs published an influential report. It was responsible for popularizing the BRICS acronym in business and economics. BRICS, of course, stands for Brazil, Russia, India, China and South Africa. The time of the report also marks the start of a shift in relative weights in the world economy towards the so-called emerging market countries. Although many analysts questioned whether Brazil should be included in such a distinguished group, few questioned that the country has undergone a most remarkable transformation in the last 100 years or so. From a poor, unsophisticated, primary exporter economy about one hundred years ago it became one of the largest and richest emerging markets of today. Economists have gone to great lengths to try to understand this important transformation. One class of potential explanations that has received considerable attention is related to finance. Various hypotheses have been put forward to explain this process of deep structural transformation but attention has focused on the roles of financial development, public finances and international financial integration.

The Brazilian case is particularly interesting to study the relationship between financial development, the instability of political institutions and economic performance because of its size (both in terms of populations and output), its hegemonic role in South American and its relatively important role globally. The latter highlights the prominent role of Brazil among emerging markets and the representativeness of our research findings in other countries especially in the region of Latin America. Furthermore, Brazil is important because despite the reputation of having a relatively peaceful history, this is a country that exhibits a huge variety of types of instability of political institutions (indeed of all the formal and informal types one can find in large cross-sections of countries) under considerable variation of contexts (empire and republic as well as over varying degrees of democracy and autocracy), over the very long time window we consider.

The chapter chiefly addresses the following questions: What is the relationship between economic growth, on the one hand, and financial development, trade openness and political instability, on the other? Does the intensity and sign of these effects vary over time? Has the transition between such possible regimes been often smooth or has it generated substantial costs and negative externalities?

Few previous studies have tried to evaluate how the explanatory power of these factors has changed over time and this is one of the main contributions of this chapter. This chapter tries to contribute to the existing literature by further investigating the time-varying link basically between finance, political instability and economic growth. It uses the smooth transition framework and annual time series data for Brazil (i.e. annual growth rate of gross domestic product (gdp), financial development, trade openness and a set of political instability indicators) covering the period from a very long time window, from 1890 to 2003. The new data we use in this chapter is for political instability. The existing measures of both formal and informal political indicators for Brazil are yearly from 1919 to 2003 with the exclusion of the World War II period (1940–1945). Our research contributes further to the literature by extending the track of political instability back to the year of 1890. More specifically, we constructed our own informal and formal political instability series from 1890 to 1919 (a period with high political uncertainty in Brazil).

Our main findings are that (a) financial development has a mixed (positive and negative) time-varying impact on economic growth (which significantly depends on jointly estimated trade openness thresholds); (b) trade openness has a positive effect, whereas (c) the effect of political instability, both formal and informal, on growth is unambiguously negative. Our findings (with respect to point (a) and (b)) provide supporting evidence on the implications of the theoretical model of Antras and Caballero (2019) who argue that when variation in financial development is a significant determinant of comparative advantage, trade flows (as well as capital flows) becomes complement in financial underdeveloped countries.

We may add that this chapter relates to several literatures in financial development, political instability, trade openness and economic growth. Regarding the body of scholarly research on the main causes of economic growth, Durlauf et al. (2005) and Acemoglu (2009) provide recent, authoritative surveys that support the view that there seems to be dissatisfaction with the empirical growth literature. This chapter tries to improve matters in this regard by focusing on a single country as opposed to following the common practice of trying to learn something about growth by focusing on the mean or median country. We believe this study can further our understanding of economic growth mainly because of two considerations. Firstly, we study only one individual country over a very long period of time with annual frequency data. Various papers allow analysis of Brazil's performance from a cross-country perspective (among others, Loayza and Ranciere, 2005), while those focusing solely on Brazil tend to cover the period from the 1930s onwards (e.g. de Paiva Abreu and Verner, 1997). Secondly, we employ an econometric methodology that has been seldom used in the empirical growth literature.

There is a growing body of evidence showing that the expansion of a country's financial sector promote its economic growth (see for instance Demirguc-Kunt and Maksimovic, 1998; King and Levine, 1993; Jayaratne and Strahan, 1996; Rajan and Zingales, 1998, Alper and Cakici, 2009, Fidrmuc et al., 2015, Durusu-Ciftci et al., 2017 and Asteriou and Spanos, 2019). However, Levine (1997) argued that our understanding of long-run economic growth will be limited until we understand the evolution and functioning of financial systems. An authoritative and up-to-date review of this literature is Zingales (2015), which highlights an important yet under researched finding in terms of divergent short and long-run effects of finance on growth. For example, Gavin and Hausmann (1996) argue that rapid financial development and expansion could cause banking crises and economic collapse. Archand et al. (2015) showed that in countries with very large financial sector, there is no positive correlation between financial depth and economic growth, while to those countries with small and medium financial sectors a positive correlation was detected.

Kaminsky and Schmukler (2003) argue that while financial development is robustly associated with economic growth, it has also often been found to be the main predictor of financial crises. That is, while the long-run effect of finance on growth is positive, the short-run effect is negative. Loayza and Ranciere (2006) report panel evidence that the negative short-run effect is sometimes larger than the positive long-run effect. Focusing on time-series evidence specifically for Argentina, Campos et al. (2012) show that the short-run effect of finance on growth was likely to be negative, but smaller than the positive long-run effect. The depth and extent of the debate surrounding substantial differences in the effect of finance on growth depending on whether one focuses on the shorter- (negative) or the (positive) longer-run suggests that further research examining this time-varying relationship would be valuable. The long time-series could allow for re-testing the hypothesis that there is a mixed time-varying impact of financial development on economic growth and the regime switching modelling (LST) would be a significant methodological approach in exploring this cavity in the case of Brazil.

Recently there has been a lot of interest in the relationship between political instability and economic growth. In a seminal chapter, using a cross section framework, Barro (1991) finds that assassinations, number of coups and revolutions have negative effects on economic growth. Campos and Nugent (2002) confirm this result by using panel data analysis but find that this negative impact (on growth) is mostly driven by sub-Saharan African countries. Yet, other researchers claim that there is no significant relationship between political instability and output growth. Easterly and Rebelo (1993) suggest that assassinations and war casualties have no significant effect on growth, while Benhabib-Spiegel (1997) and Sala-i-Martin (1997) support this argument using different data and methodologies. Knack and Keefer (1995) compared more direct measures of institutional environment (such as the security of property rights and the Gastil indicators of political freedoms and civil liberties) with instability proxies utilized by Barro (1991). They argue that institutions that protect property rights are important for economic growth.

Roland (2008) proposes a classification of "slow-moving" and "fast-moving" institutions and explains the potential implications of their interaction. This interaction reveals the problem of transplanting institutions into distinct cultural environments and the advantages of very different institutional systems for efficient growth and development. Finally, Spruk (2016a) examined the impact of de jure and de facto political institutions on the long-run economic growth for a large panel of countries. The empirical evidence suggested among others that societies with more extractive political institutions in Latin America

experienced slower long-run economic growth and failed to converge with the West.

An important issue regards the channels through which political instability (that is, changes in formal and informal institutions) is expected to influence growth. It might be expected that instability will make property rights less secure and transaction costs too high, the rule of law weak and state capacity too thin to support sustained growth episodes. For example, Torstensson (1994) argues that many developing countries lack secure private property rights and that arbitrary seizures of property slow down economic growth. Kovac and Spruk (2016) quantified the impact of transaction costs on cross-country economic growth and find a significant negative effect of increasing transaction costs on growth. Weingast (1997) puts forward a game-theoretic framework to study the issue of political officials' respect for the political and economic rights of citizens in which democratic stability and the rule of law entails that political officials have motives to honor a range of self-enforcing limits on their behavior. Concluding, Acemoglu et al. (2015) study the direct and spillover effects of local state capacity in Colombia and find that the existence of central and local states with the ability to impose law and order is vital for economic development. They also note that the efficiency of state capacity is affected by various factors such as geographic, historical, political and social ones.

Another literature strand to which we contribute is that of trade openness. The idea that trade liberalization is the horsepower of growth has its roots back in Adam Smith. Among others Krueger (1978) and Wacziarg and Welch (2008) argued that trade openness does indeed lead to higher growth rates. The IMF (1997) has stated that policies favoring international trade are among the most significant elements in promoting economic expansion and convergence in developing countries. In addition, a report from the OECD (1998) concluded that more open and outward oriented economies tend to surpass countries with restrictive and more isolated trade policies. Finally, Fischer (2000) during a lecture (for further information see Rodriguez and Rodrik, 2001), argued that the optimal way for a nation to grow is to harmonize its policies with the global economy.

However, these arguments were lacking general approval especially after the Great War in developing countries and in particular Latin America, which very often adopted the so-called Import Substitution Industrialization policies that imposed barriers on international trade (see also Dean, 1995 for more details). The outbreak of World War II turned Latin America back to protectionism and to high tariff policies and it was not until the 1990s when liberal policies took effect (Edwards, 1994). However, these arguments were lacking general approval especially after the Great War in developing countries and in particular Latin America, which very often adopted the so-called Import Substitution Industrialization policies that imposed barriers on international trade. The outbreak of World War II turned Latin America back to protectionism and to high tariff policies and it was not until the 1990s when liberal policies took effect (Edwards, 1994).

The chapter is organized as follows. Section 3.2 presents a brief early economic and political history, which explains the economic performance of Brazil from 1890 to 2003. Section 3.3 describes the data whereas Section 3.4 provides details and justification for our econometric methodology. Section 3.5 discusses our baseline econometric results. Section 3.6 concludes and suggests directions for future research.

3.2 Background: Brazilian Economic and Political History

This Section, provides general background information about the main developments in Brazilian economic history. The reason for this is to help judge the range of variables we choose to focus on in the econometric analysis as well as to better evaluate our main estimation results. Our data start in 1890 as such covers the following main political periods: the First Republic from 1889 to 1930, the Vargas Era from 1930 to 1945, the Second Republic from 1945 to 1964, the Military Dictatorship from 1964 to 1985, and the new democratic period since 1985.

The military started to express opinions publicly and debate governmental policies in 1879. More specifically they supported education, industrialization, the abolition of the slavery, regeneration of the nation and the guarding of the fatherland (the so-called soldier citizen), by proclaiming them as agents of social change. Under Mariscal Deodoro's orders, on November 15^{th} 1889, the army captured the Royal Palace, the main governmental building and silenced Rio de Janeiro. The day after November the 15^{th}, Deodoro declared Brazil a federal republic. The period that followed, the First Republic (1889-1930), was characterized by political unrest as well as the politics of 'coffee and milk' (known as cafe com leite),

a combination of the Sao Paulo coffee and the Minas Gerais milk political elites. The main target of the First Republic was to balance the power between these two oligarchic elites and the army. However, the problems of the oligarchic system developed further. More specifically the 'tenent revolt' of 1922 and 1924 rocked the interior of Brazil.

During the Great Depression of 1929, coffee exports were brought to a deadlock, while the Paulista elites chose to end of the politics of coffee with milk agreement unilaterally. In 1930, political protest erupted, for example the Revolta da Princesa outburst in the Northeastern state of Paraiba and the assassination of João Pessoa, the governor of Paraiba, occurred. Shortly after Pessoa's death, more riots followed, including the Revolution of 1930, on October 24th 1930. Getulio Vargas, after failing to be elected president in 1930, led a revolt that took him to power. From 1930 until 1934 he ruled Brazil as a dictator[18], from 1934 to 1937 he was elected as president and then again as a dictator from 1937 to 1945. Under the Estado Novo (1937-1945), all political parties were dissolved and governors were replaced (see Hudson, 1998). After 1945, Vargas still served as a senator until 1951, when he was elected President in general elections, a position which he held until 1954. Hence Getulio Vargas played a central political role in Brazil for nearly 24 years. According to Maddison (1995), during the Vargas era (and up to 1980) Brazilian economic growth rates were among the highest in the world. The Vargas years had a significant impact on national politics and economics. Even in the 1990s, the local political leaders were still called colonels. During this era, reorganization of the armed forces, the economy, international trade and foreign relations took place. The average annual gdp growth rate during that period was 4%. Finally, the 1930-1945 period added a new term to the Brazilian political lexicon, that of corporatism[19]. Vargas's influence in Brazilian politics remained indelible for decades (Hudson, 1998).

If corporatism was the benchmark of the 30s and 40s period, populism, nationalism and developmentalism dominated the two following decades (the 50s and 60s). Each of these terms contributed to the crisis that occurred in Brazil, which resulted in the authoritarian regime that occurred after 1964. By the early 1960s, Brazilian society was in ferment. Labor classes became more and more active, seeking a better future, and the population continued to grow beyond the state's capability to increase educational and social services. As a consequence, the conservative elites alongside the middle classes, which tended to follow the elites' vision and considered the lower classes as a threat, feared that they were going to lose control of politics and of the state. It was the same elites that opposed Vargas due to his intention to use the state for a fairer distribution of resources. During the period 1956-1961 Juscelino Kubitschek (who was the only post Vargas elected president to serve a full term), promoted the establishment of an automotive industry, which could help Brazil to overcome economic stagnation. The new factories produced 321,000 vehicles in 1960. Among his legacies are the world's eighth largest automobile production and a great highway network of the late twentieth century. Constant motorized advancement in farm equipment and changes in transportation transformed the vast countryside areas of Mato Grosso and Goias, making Brazil the worlds number two food exporter. All these led the overall economy to grow by 8.3% a year. Hence it could be argued that there was a lot of truth in the Kubitschek government's motto 'Fifty Years' Progress in Five'(Hudson, 1998).

Brazil in 1960 was completely different from that of 1930. The population reached 70 million from 34 million in 1930, with 44% residing in urban areas. Life expectancy increased as well. The number of workers increased from 1.6 million in 1940 to 2.9 million in 1960, an approximate 100% increase in 20 years. The share of industrial productivity as a percentage of gdp was higher (25.2%) than that of agriculture (22.5%). On the other hand the annual rate of inflation kept rising from 12% in 1949 to 26% in 1959 and to a shocking 39.5% in 1960. Savings depreciated and lenders were unwilling to offer the long term loans that are essential for investment. High interest rates and the government's refusal to comply with the International Monetary Fund (IMF) conditions created a negative environment among the people. The large differences between the poor and rich remained, with 40% of the national income to be enjoyed by 10% of the population, 36% going to the next 30% and the remaining 24% distributed to the remaining 60% of the population. Struggling to maintain control, the government of João Goulart[20], in a huge rally in Rio de Janeiro on March 13^{th} 1964, attempted to promote reforms. An opposition rally

[18] In 1930 Getulio Vargas was selected as the candidate of the Alianca Liberal (Liberal Alliance).

[19] The term developed mostly in Italy under Benito Mussolini. Corporatism is a concept opposite to that of Marxism and Liberal Democratic political philosophies.

[20] 4^{th} Vice President, a populist and a minister of labor under Vargas won the presidency on the 7^{th} of September 1961 unitl the 1^{st} of April 1964 that he abolished the power.

was held six days later in Sao Paulo, putting 500,000 people in the streets. Rio de Janeiro's Correio da Manha (a daily newspaper from Rio de Janeiro) featured an unconventional front cover with the headline 'Enough', while the subsequent day's cover was titled 'Out'. In the next few days the military intervened to secure the country and Goulart fled to Uruguay. The period of the military republic (1964-1985) had begun. In summary, the 1950s and 1960s were marked by high political instability, which in turn affected the level of the trade openness of the Brazilian economy in different ways.

As with the previous regime changes of 1889, 1930 and 1945, the coup of 1964 divided the military into two groups. The first one included those who believed that they should focus on their professional duties and the second group, the hard-liners, were those who believed that politicians were betrayers that would deliver Brazil to communism. The dominance of the hard liners' opinion led Brazil into what a political scientist (named Juan J. Linz) defined as an authoritarian situation. In 1983 the economy was running with average gdp growth of 5.4%, but the importance of this was diminished by the rising inflation and weak and disheartening political leadership. Millions of Brazilians went out to the streets in all major cities demanding a direct vote (diretas ja). In April 1984, Congress failed to achieve the necessary numbers in order to satisfy the people's wish and the choice was left to an electoral college.

On January 15^{th} 1985, the Electoral College elected Tancredo Neves of Minas Gerais (Varga's minister of justice in the 1950s and former federal deputy, senator and prime minister), who died a year later. Similarly to the regime changes of 1822, 1889, 1930, 1946 and 1964, the 1985 change would prove to be full of obstacles as well. Some years later it was Fernando Collor de Mello's turn to rule the country (in office from 1990 to 1992). Mello was the first Brazilian president elected directly by the people. During his term in office he attempted to control hyperinflation and started a massive program of privatization of state-owned firms. His tenure ended in 1992 with the presidency of Itamar Franco, who stayed in power until 1995. The last five years of the 20^{th} century found Fernando Henrique Cardoso in office. His administration was characterized by the promotion of human rights in Brazil.

To sum up, the period since 1890 is a significant era for Brazilian history since the country experienced significant economic and political expansion, being transformed to an emerging market and forming one of the BRIC countries. However, there is an ongoing debate which tries to identify the key factors that are responsible for this astonishing route. Financial development, trade openness, financial integration and macroeconomic stability are the main factors that most of the previous literature has paid attention to. This chapter will attempt to shed light on the main causes of economic growth since there seems to be dissatisfaction within the empirical growth literature. Using data that cover a period from 1890 to 2003 we will try to explain (under a smooth transition approach) the role that financial development, trade openness and political instability played in economic growth and the transformation of Brazil in general.

3.3 Data

Our data set contains annual data for economic growth, financial development, trade openness and political instability for Brazil between 1890 and 2003, excluding the World War years. The main data source for the first three is Mitchell (2003), see Figure 3.1 below. Economic growth is measured as annual growth rate of gdp at level. Our measure of financial development is commercial bank deposits over gdp (cbd) defined as the sum of time deposits in commercial banks and deposits at the end of the period in commercial banks and it tries to capture the efficiency of the financial sector[21]. Data have been reported by Mitchell (2003) but due to missing values we follow the approach of Pelaez and Suzigan (1976) to reconstruct the series.

One note of caution is that there are various aspects of financial development that may be considered important but for which data are only available after approximately 1950 or 1960 (e.g., share of credit to the private sector over gdp[22], intermediation spreads, bank credit, and bank credit/deposits ratio) and hence, cannot be used in the present study.

As far as trade openness is concerned we use the ratio of exports plus imports as a share of gdp (we also plot the exports and imports as a share of gdp, see Figure B1 in the Appendix). In addition

[21] A similar indicator of financial development has been used by Rajan and Zingales (2003).

[22] Though not a measure of "efficiency" and is also a very poor measure of financial development, see IMF Financial Development database and the associated IMF staff discussion note by Sahay et al. (2015).

the correlation coefficient of exports and imports (as a share of gdp) with respect to openness, that is $\rho_{\exp to} = 0.98$ and $\rho_{\exp to} = 0.97$ respectively.

This chapter captures the changes in trade policies by using trade openness as the transition variable in the case of Brazil for the following reasons. According to the United Nations' statistical agency[23] it is a major exporter of iron ore and concentrates, petroleum oil, soya beans, coffee and processed meat, as it is involved in the manufacture of small aircraft. Finally, the importance of trade policies for successive Brazilian governments is apparent from: the fact that its patent law dates back to 1809; their participation in every international conference associated with intellectual property rights since that time; and their signing of GATT in 1947 (General Agreement on Tariffs and Trade) founding declaration (Lattimore and Kowalski, 2009). Table A1 in the Appendix reports the descriptive statistics.

Construction of the New Political Instability Dataset

The new data we use in this chapter is for political instability (available from 1890 to 2003, Campos et al., 2020). We use a taxonomy of political instability divided into two categories, informal and formal (Campos et al., 2012). Formal political instability originates from within the political system, informal from outside. Our starting point as the source of historical annual data for various types of political instability is Arthur Banks's Cross National Time Series Data Archive (CNTS). The informal political instability measures consist of the number of demonstrations (dem), defined as peaceful public gatherings of at least 100 people and the number of strikes (str) of 1000 or more workers involving multiple employers and aimed at government policies (see Figure 3.2 below).

Formal political instability is measured by legislative selection (ls) and legislative elections (le). The latter is defined as follows:

(0) None. No legislature exists.

(1) Ineffective. There are three possible bases for this coding: first, legislative activity may be essentially of a "rubber stamp" character; second, domestic turmoil may make the implementation of legislation impossible; third, the effective executive may prevent the legislature from meeting, or otherwise substantially impede the exercise of its functions.

(2) Partially Effective. A situation in which the effective executives' power substantially outweighs, but does not completely dominate, that of the legislature.

(3) Effective. The possession of significant governmental autonomy by the legislature, including, typically, substantial authority in regard to taxation and disbursement, and the power to override executive vetoes of legislation.

Legislative selection takes the value 0 when no legislature exists, the value 1 in the case of nonelective legislature and 2 when legislators or members of the lower house in a bicameral system are selected by means of either direct or indirect popular election (see Figure 3.3 below).

For these formal and informal political instability variables, Banks data (2005) do not exist for the pre-1918 period. In the spirit of Acemoglu et al. (2019) and according to the definitions of the political instability variables above, all relevant political events from years 1890 to 1939 were catalogued and classified into different types of political instability (see Campos et al., 2020). We then took advantage of an intentional overlap between the series during the period 1919 to 1939 to assess the reliability of the new information. We find that there are a few circumstances where there is mild disagreement between the two series and thus argue that the new data series is a reliable as the more standard CNTS data[24]. This extension increases the availability of the data in the case of Brazil which in turn is crucial in time series analysis as well as for future research[25].

Our political instability variables enter our econometric framework one by one and thus the results are not affected by the taxonomy itself. Our main formal and informal political instability measurements are demonstrations and legislative selections whereas the other two (i.e. strikes and legislative elections) serve as robustness checks.

[23] For further information regarding Brazil's profile please check the: http://comtrade.un.org

[24] For more details regarding the construction of the political instability data see Campos et al., (2020).

[25] Following Campos et al. (2020), since 2003 the political environment of Brazil became significantly less unstable meaning that most of the political instability indicators would take the value of 0 (affecting adversely the robustness of our results in the context of the smooth transition modelling).

Comparison With Other Measures of Democracy and Institutional Development

How are our measures of informal and formal political instability related to the existing measures of Brazil's institutional development? Although our definitions and coding do not strictly match the concepts and measurements of democracy and institutional development introduced in past literature, we can still find some substantial correlations between our political instability indicators and those measures introduced by Acemoglu et al. (2002), Boix et al. (2013), Lindberg et al. (2014) and Spruk (2016a, 2016b) such as the executive constraints, dichotomous measures of democracy, various electoral factors and de jure and de facto political institutions respectively. The latter highlights and assesses the comparability and accuracy of our new dataset respectively as well as enhances the contribution of our chapter to economic growth literature.

More specifically, Acemoglu et al. (2002) argue in favor of a reversal in relative incomes among the former European colonies due to European intervention which in turn created an "institutional reversal". To quantify institutions, they employed among others the constraints on the executive (a variable described in Gurr, 1996, and later updated in Marshall et al., 2015) from Polity III data set, which serves as a proxy for the level of concentration of political power in the hands of ruling groups. We then explore how our coding matches with that of Marshall et al. (2015). Despite the different scaling between our measures and that of Marshal et al. (2015) we notice from Figures 3.3 (see legislative selection) below and 3.A1.a (in the Appendix) that legislative selection and executive constraints are highly correlated.

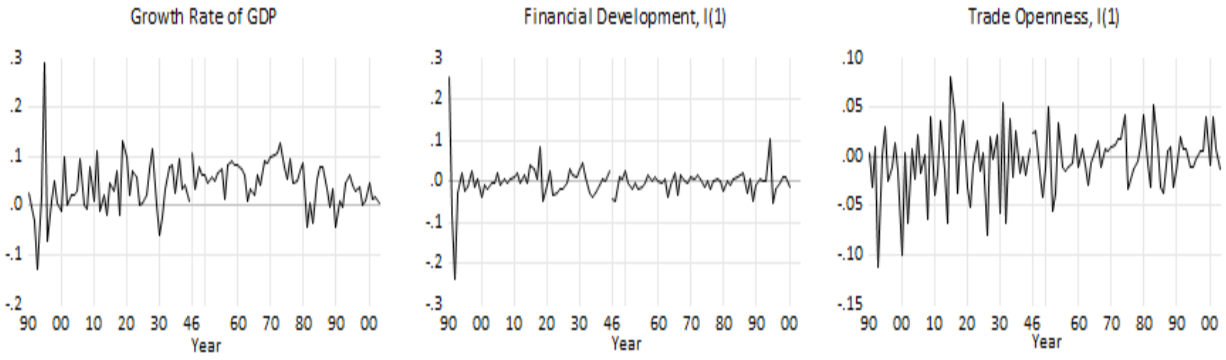
Boix et al. (2013) update and describe an extensively used dataset on democracy covering a very long period of time, from 1800 to 2007 and 219 countries and representing the most comprehensive dichotomous measure of democracy (see Figure 3.A1.b). Figures 3.2 (see demonstrations) and 3.A1.b entail that there is a significant correlation between the dichotomous measure of democracy (Boix et al., 2013) and our political instability indicator of demonstrations. Looking at those two graphs we notice that up to almost 1950 where the country was democratically repressed the number of demonstrations were almost zero. This trend started reversing from 1950 and especially from 1980 onward when democratic values began to emerge.

Furthermore, Lindberg et al. (2014) generated a new dataset that measures democracy, the so-called Varieties of Democracy Project (V-Dem). Due to the lack of consensus on how to measure democracy they emphasize on its multidimensionality. Out of the five principles that the authors follow in order to conceptualize democracy, we estimate high correlation coefficients between various electoral [such as election vote buy, elections free and fair, head of state legislation in practice and party ban (see Figure 3.A1.c)] and liberal [such as executive respects constitution and freedom from political killings (see Figure 3.A1.d)] components and our informal (namely demonstrations and strikes) and formal (namely legislative selection and legislative elections) political instability indicators (due to space limitations, we project only a sample of the electoral and liberal components).

Concluding, Spruk (2016a, 2016b) measured institutional changes and investigated the impact of de jure and de facto political institutions on the long-run economic growth for a large panel of countries in the period 1810-2000 (due to space limitations see Figure 3.A1.e for a sample of those components). Comparing with their data set we estimate high correlation between their de jure (and in particular competitiveness and openness of executive recruitment) and de facto components (civil liberties and political rights) and our informal (namely demonstrations) and formal (such as legislative elections and legislative selection) political instability indicators. The data for the de facto components, namely civil and political rights, were available from 1972 onward for Brazil.

Because the original series (with the exemption of growth rate of gdp and the political instability measures) of financial development and trade openness are I(1), they are included in our models in first differences for stationarity purposes. Results from the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests are presented in Table 3.1 below. Both suggest that either the level of the series or their first differences are stationary. In addition, unit root tests with breaks provided by Zivot and Andrews (1992) have been conducted (Table 3.A2 in the Appendix 2). In all cases the unit root hypothesis is rejected at 1% and 10% level respectively (with the exception of le that fails to reject the unit root hypothesis when we allow for a break in the trend: see Table 3.A2 in the Appendix 2, third column).

Figure 3.1. Growth Rate of GDP, Financial Development and Trade Openness



Notes: The y-axis shows the growth rate and the first difference of the gdp and financial development and trade openness respectively.

Figure 3.2. Informal Political Instability Measures

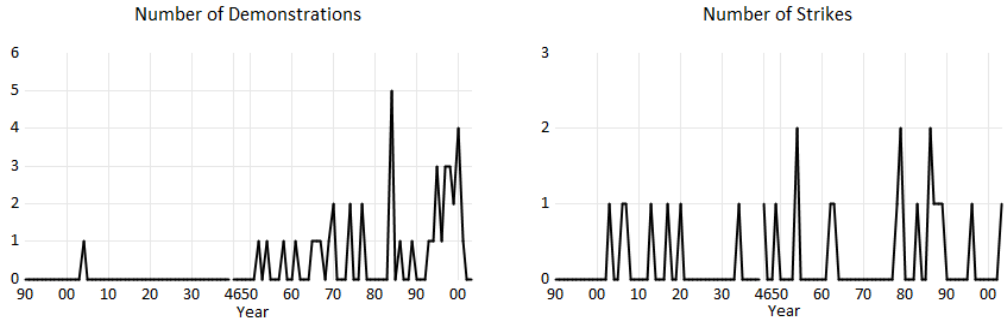
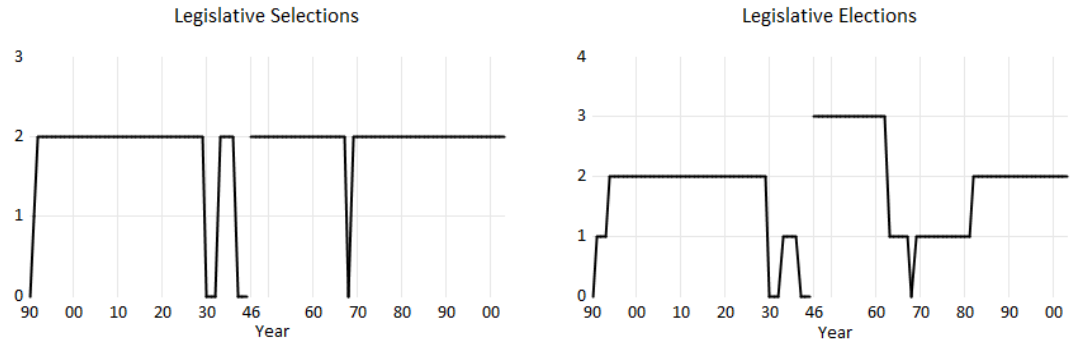


Figure 3.3. Formal Political Instability Measures



Notes: The y-axis shows the number of demonstrations, strikes and legislative selections/elections.

Table 3.1. Augmented Dickey Fuller (ADF) and Phillips Perron (PP) Unit Root Tests.

Variable	ADF at level	ADF at first difference	PP at level	PP at difference
gdp	-9.29^{***}		-9.29^{***}	
cbd		-12.35^{***}		-11.94^{***}
to		-13.00^{***}		-13.00^{***}
dem	-4.54^{***}		-7.37^{***}	
str	-8.99^{***}		-8.99^{***}	
ls	-6.29^{***}		-6.37^{***}	
le	-3.63^{***}		-3.69^{***}	

Notes: *** indicate significance at 1% level. Numbers represent the estimated ADF and PP t-statistics respectively. Both tests suggest that either the level of the series or their first difference are stationary at 1% level.

3.4 Econometric Framework

Non-linear models have attracted the interest of more and more researchers in recent years. Economic variables are subject to switching regimes. From recent studies in univariate modelling, we learn that there are a lot of benefits in allowing nonlinear specifications. While from one side the regime switch implies a sudden abrupt change on the other most economic variables change regimes in a smooth way (i.e., transition from one regime to the other needs some time to take place). To address this issue the smooth transition regression models have recently been developed (Kavkler et al., 2007).

An advantage of the smooth transition regressions (comparing to the discrete switching models see for example Hansen, 2000) is that they model transition as a continuous process dependent on the transition variable. The latter allows for incorporating regime switching behaviour (i) when the exact time of the regime change is not known with certainty and (ii) when there is a short transition period to a new regime. Therefore, these models provide additional information on the dynamics of variables that show their value even during the transition period.

Capturing nonlinearities and regime switching makes smooth transition models good candidates for analysis of numerous transition economies, such as Brazil, and economic variables. First, because these models naturally lend themselves to modelling institutional structural breaks. Thus, they may be a useful tool to study transition economies characterised by many structural breaks in the early part of transition. Second, several authors provide evidence of asymmetries in the dynamics of economic variables, depending on the magnitudes of parameters, in established market economies (see Johansen, 2002 and Milas and Legrenzi, 2006).

In the literature of business cycles or trade openness, it is very common practise to distinguish only two regimes associated with recessions and expansions. Given that in our chapter the transition function is trade openness we consider two-regimes associated with open (high level of trade openness) and closed economy (low level of trade openness). At this point it is worth mentioning that the smooth transition modelling allows for only two regimes (associated with the extreme values of the transition function $G = 0$ and $G = 1$, whereas the transition between the two regimes is gradual). Nevertheless, we acknowledge the fact that while this is sufficient for most practical cases such as the case of Brazil, sometimes it might be interesting to consider the possibility of more than two regimes. The latter could be examined in future research by utilizing models that allow for multiple regimes.

Teräsvirta (1994) suggested a specification technique of three stages, assuming that if the process is not linear, then the alternative might be a smooth transition (ST) autoregressive model, which captures regime-switching behavior. The first stage of the estimation procedure is to identify a linear autoregressive model. The second focuses on testing linearity for different values of d, the delay parameter, and the third one on choosing between an exponential ST (EST) or a LST model by testing a sequence of three hypotheses (see Teräsvirta, 1994, 1998). Nevertheless, initial estimation of both EST and LST models and the usage of postestimation information criteria could provide us with the final choice between models, Teräsvirta (1994, 1998). The ST model for the economic growth series y_t is given by

$$y_t = \boldsymbol{\phi}_1' \mathbf{x}_{t-l} + \boldsymbol{\phi}_2^{'} \mathbf{x}_{t-l} G(s_{t-d}) + \epsilon_t \tag{3.1}$$

where $x_{t-l} = (1,\, x_{2,t-l}, \ldots, x_{k,t-l})'$ is the $k \times 1$ vector of the explanatory variables, $\phi_i = (\phi_1^{(i)}, ..., \phi_k^{(i)})'$, $i = 1, 2$, are the $k \times 1$ vectors of coefficients and $G(s_{t-d})$ is the transition function (see eq. 3.2 below), which changes smoothly from 0 to 1 as the transition variable s_{t-d} (which can be a lagged endogenous variable y_{t-d} for a certain integer $d > 0$, an exogenous variable, a possibly nonlinear function of lagged endogenous and exogenous variables or a linear time trend, see van Dijk, 1999) increases. Because of this property (i.e. the transition function changes smoothly from 0 to 1), not only the two extreme states can be explained by the model, but also a sequence of regimes that lie between those two extremes. The term d determines the lag-length of the transition variable and $\{\varepsilon_t\}$ is a sequence of independently and identically distributed (i.i.d) errors ($\varepsilon_t \sim nid\,(0, \sigma_\epsilon^2)$). Here we use the first order logistic function, which is defined as:

$$G(s_{t-d}) = \frac{1}{1 + e^{-\gamma(s_{t-d} - c)}}, \tag{3.2}$$

where γ determines how smooth the change in the value of the logistic function is (and hence the transition from one regime to another) and the intercept c is the threshold between regimes. In eq. 3.2, when the smoothness parameter becomes very large, $\gamma \to \infty$, then the transition is said to be abrupt. When $\gamma \to 0$ the logistic function approaches a constant. Thus when $\gamma = 0$ the LST model reduces to the linear model. The advantage of an ST against a threshold autoregressive (TAR) model is that the conditional mean function is differentiable (Tsay, 2010). For recent developments of the ST regression model and its applications see Espinoza et al. (2010), Dueker et al. (2013), Silvennoinen and Teräsvirta (2015), Gonzalez et al. (2017) and Shahbaz et al. (2017).

However Teräsvirta, (1994) noted that the joint estimation of the transition parameters γ and c is uncertain. Nonetheless, these uncertainties around the accurate estimation of transition parameters γ and c, do not affect the other estimates of the model. Following Teräsvirta (1994, 1998) we test whether the non-linear model is preferred and if the use of the logistic function is warranted (LM_2). After rejecting linearity LM_2 or its F version, Teräsvirta (1994) outlines a sequence of ordinary F tests to choose between the LST and EST models. First, the rejection of H01 can in principle be interpreted as a rejection of the EST model. Second if H02 is not rejected, then this is taken as a further evidence in favor of a LST model (although a rejection of this hypothesis is not informative yet). The last F test in the sequence is the H03. Rejecting H03 after accepting H02 supports the choice of a LST model. In the case where you accept H03 after rejecting H02 the methodology points at an EST model.

The economic history of Brazil demonstrates the close relation between trade openness and economic growth (Baer, 2013), so trade openness is clearly the most intuitive choice for our transition variable. The reasons for the choice of trade openness as our transition variable are not just easily found in economic history but this choice is also fully supported econometrically by standard linearity tests. In particular, when financial development is used as the transition variable they fail to reject the linearity hypothesis (from now on LM_2) in two cases (demonstrations and legislative elections) while for the other two (strikes and legislative selections) the p-values of LM_2 are weaker than those when trade openness is the transition variable. Similarly, economic growth fails to reject the linearity hypothesis in most of the cases when it serves as a transition variable[26].

The reason why we do not test linearity using political instability as the transition variable is simply because our measures contain many 0 values. When $s_{t-d} = 0$, then the transition function (see eq. 3.2 above) becomes 0 and hence the model, in equation 1, reduces to a linear one. A range of linearity tests suggests the use of LST instead of the EST model (see Table 3.2 below). The only case in which an ESTAR is the preferred choice is when legislative elections serve as the political instability measure. However, based on Teräsvirta (1994) the choice between an EST or an LST model could be postponed until both types of models are estimated and evaluated using postestimation criteria. In our case, an LSTAR model seemed more suitable[27]. We use the RATS software to estimate eq. (3.1) and (3.2) above.

[26] See Tables 3.2, 3.A3 and 3.A4 in the Appendix 2.

[27] The decision was determined by the post-estimation Ljung and Box statistic for residual autocorrelation (LBQ) and on the minimum value of the Akaike information criterion.

As mentioned above, Teräsvirta (1994) argues that specifying a linear autoregressive model constitutes the first stage of the estimation procedure.

We select the optimal lag length that rejects stronger linearity, that is, for financial development $l = 3$, while for demonstrations $l = 4$[28]. For trade openness and legislative selections the selection of $l = 4$ is made on the basis of the minimum value of LBQ and the General to Simple (GS) information criterion (see Table 3.3 below). The choice of the delay parameter is based on the optimal linearity of rejection among different values of d. Thus, we get $d = 4$. The parsimonious model (as indicated by AIC and LB statistics for the residual autocorrelation) had the greatest explanatory power when it contained the constant, the 3rd lag of commercial bank deposits (cbd), and the 4th lag of various measures of political instability (pi) and trade openness (to). That is, $x_{t-l} = (1, cbd_{t-3}, pi_{t-4}, to_{t-4})$. The model of choice was the one with $\phi_4^{(2)} = 0$ and where the regime indicator variable s_{t-d} was set to be to_{t-4}. The autoregressive coefficients of economic growth are highly statistically insignificant and hence excluded from our regression model. Consequently, the model specification reduces to a smooth transition regression (STR), for an in-depth analysis of the STR model, see Teräsvirta, (1998).

Concluding, our lagged regression coefficients report the time-varying effect of financial development, trade openness and political instability on growth in the short-run.

Table 3.2. Linearity Testing, Determining the Delay Parameter and Selection Between LSTAR and ESTAR. Trade Openness is used as a Threshold.

Variable	Linearity LM_2	p-value H01	p-value H02	p-value H03	d-delay parameter	TP choice
dem	0.02	0.01	0.84	0.03	4	LSTAR
str	0.01	0.02	0.16	0.13	4	LSTAR
ls	0.01	0.27	0.13	0.01	4	LSTAR
le	0.01	0.25	0.02	0.03	4	ESTAR*

Notes: Column 2 represents the p-value (strength) of the linearity rejection. Based on the Teräsvirta (1994) selection process, columns 3 to 5 suggest an LSTAR model except from *le*. However, the use of the LSTAR model fits better in our data. Column 6 represents the delay parameter, which in our case is 4, since the power of linearity rejection is stronger relative to other values of d. The usage of LM_2, H01, H02 and H03 follows Teräsvirta (1994).

Table 3.3. Lag Specification

Variables	Information Criteria				
	AIC	SBIC	LBQ	LM	GS
cbd	0	0	1	0	2
to	5	1	1	1	**4**
dem	**3**	2	2	2	2
str	0	0	0	0	0
ls	7	1	**4**	1	3
le	8	1	1	1	8

Notes: The Table reports the maximum lag-length on the basis of minimum information criteria*. For the cases of *to* and *ls* we choose four lags (numbers in bold). For *cbd*, *dem* the optimal lag-length is two for *str* zero and for *le* eight. However, for linearity rejection purposes we use three lags for *cbd* and four for *dem, str* and *le* respectively. *LM stands for Lagrange multiplier test for residual serial correlation.

[28] The right lag structure for the model can be chosen typically via the AIC or the Schwarz information criterion (SBIC). Yet, a decision based on SBIC may yield too parsimonious models since estimated residuals from the chosen model may be subject to serial correlation. As such, models provided by information criteria should be tested for residual serial correlation using such tests as the Ljung and Box portmanteau test. Also Luukkonen et al. (1990) noted that in the case of US unemployment, linearity may be rejected as the lag length increases, suggesting the importance of longer lags in explaining nonlinearity on the one hand and the weakness of shorter ones on the other.

3.5 Empirical Results

In this section we use the smooth transition model [following the model specification procedure of Teräsvirta (1994)] to investigate the relationship between economic growth, financial development and political instability with the level of trade openness in the economy as the transition variable[29]. By estimating eq. 3.2, Table 3.4 reports our baseline results:

Table 3.4. Logistic Smooth Transition Model

	$\phi_1^{(1)}$	$\phi_2^{(1)}$	$\phi_3^{(1)}$	$\phi_4^{(1)}$	$\phi_1^{(2)}$	$\phi_2^{(2)}$	$\phi_3^{(2)}$	γ	c
dem	0.08^{***}	-0.86^{***}	-0.04^{***}	0.58^{**}	-0.04	1.16^{***}	0.04^{**}	5.54	-0.008
	(0.02)	(0.18)	(0.02)	(0.28)	(0.02)	(0.38)	(0.02)	(5.07)	(0.00)
str	0.09^{***}	-0.86^{***}	-0.03^{**}	0.76^{*}	-0.06	1.21^{***}	0.03	3.52	-0.007
	(0.03)	(0.25)	(0.01)	(0.41)	(0.05)	(0.51)	(0.02)	(2.84)	(0.00)
ls	0.14^{***}	-0.78^{***}	-0.04^{***}	0.69^{**}	-0.12^{*}	1.18^{***}	0.04^{*}	3.94	-0.005
	(0.03)	(0.21)	(0.01)	(0.34)	(0.06)	(0.46)	(0.02)	(3.11)	(0.00)
le	0.13^{**}	-1.02^{**}	-0.02^{**}	0.91	-0.14	1.62^{*}	0.03	2.02	-0.005
	(0.06)	(0.46)	(0.01)	(0.60)	(0.11)	(0.88)	(0.02)	(1.50)	(0.00)

Notes: Table 3.4. reports parameter estimates for the following model (see eq.2):

$$y_t = \phi_1^{(1)} + \phi_2^{(1)} cbd_{t-3} + \phi_3^{(1)} pi_{t-4} + \phi_4^{(1)} to_{t-4} + (\phi_1^{(2)} + \phi_2^{(2)} cbd_{t-3} + \phi_3^{(2)} pi_{t-4})(1 + \exp[-\gamma(to_{t-4} - c)])^{-1} + \epsilon_t.$$

The numbers in parentheses represent standard errors.

***, **, * indicates significance at the 1%, 5% and 10% level respectively.

To test whether our results are robust to any residual autocorrelation and thus potential misspecification, we ran a portmanteau LB. Our findings revealed no residual serial correlation (see Table 3.A5 in the Appendix 2 for the LB statistic as well as the F-statistic for each model of Table 3.4).

The three equations below estimate time-varying effects of trade openness, political instability, and financial development on growth:

[29] To validate our results we additionally used money supply and deposits at Banco do Brasil as nancial development measurements (for more details see Campos et al., 2016).

$$\frac{\vartheta(y_t)}{\vartheta(to_{t-4})} = \phi_4^{(1)} + \gamma(\phi_1^{(2)}+\phi_2^{(2)}cbd_{t-3}+\phi_3^{(2)}pi_{t-4})\exp[-\gamma(to_{t-4}-c)](1+\exp[-\gamma(to_{t-4}-c)])^{-2}, \quad (3.3)$$

$$\frac{\vartheta(y_t)}{\vartheta(pi_{t-4})} = \phi_3^{(1)} + \phi_3^{(2)}(1+\exp[-\gamma(to_{t-4}-c)])^{-1}, \text{ and} \quad (3.4)$$

$$\frac{\vartheta(y_t)}{\vartheta(cbd_{t-3})} = \phi_2^{(1)} + \phi_2^{(2)}(1+\exp[-\gamma(to_{t-4}-c)])^{-1}. \quad (3.5)$$

First note the strong positive time-dependent correlation between economic growth amd trade openness (see eq. 3.3 above and Figure 3.4 below[30]). The average marginal effect of trade openness on economic growth is reported in Table 3.A6 in the Appendix. The lowest effects of trade openness are observed in five periods. The first one is between 1908-1910, which shows the consequences of the Taubate Convention, signed in 1906, in which it was proposed that the government should buy the excess coffee production at a minimum preestablished price and that it should also restrict the production of low-quality coffee, stimulate internal consumption, and promote the product abroad (Luna and Klein, 2014). The second period in which low trade openness effects were observed covers the period from 1929 to 1933 (Great Depression), the third one from 1951 to 1954(adoption of Import Substitution Policies, Korean War), the fourth from 1982 to 1989 (hyperinflation, low net capital inflows as a share of gdp, Edwards 1994) and the final one during 1993, where slow down of the world economy and of productivity gains, and real exchange rate appreciation in Latin America occurred. Regarding the time-varying impact of political instability (either informal or formal) on economic growth the results show that they are negative throughout (see eq. 3.4 above and Table 3.A6 for the average marginal effects).

Our principal findings refer to financial development: Figure 3.4 shows our estimates for this mixed time-varying relationship (see also Table 3.A6 for the average marginal effects of financial development on growth). Notwithstanding the annual frequency, we estimate a negative effect in 56 cases (years) out of 104 (see eq. 3.5 above). For example, in three periods financial development has a clearly positive effect on economic growth, namely 1968-1974, 1991-1993 and 1997-1999. The first period is the one known as the "Brazilian Miracle", when average annual growth rates were high following a number of important financial sector reforms that underpinned a massive increase in infrastructure investment (Goldsmith, 1986). During the 1990s there were various attempts to develop non-inflationary sources of finance and to diminish Brazil's dependency on foreign savings. Despite the political turmoil that marked the early 1990s, 1991 saw law changes allowing foreign institutions to trade domestically issued bonds and securities (Studart, 2000). From 1992 onwards capital flows rose rapidly. One main source of this capital was repatriation of the capital that fled in the 1980s after the interest rate shocks of 1979. The third period covers the late 1990s and this might be explained as the consequences of the successful implementation of the "1994 Real Plan" and the expansion of the PROER programme from 1997 onwards, which supported a wave of mergers and acquisitions in the financial sector (Folkerts-Landau et al., 1997). Moreover, the opening of the Brazilian market to new financial institutions led to the development of the financial system (Bittencourt, 2011). Finally, we find that in the majority of the cases/years financial development is negatively correlated with trade openness in Brazil[31]. In particular our estimates show that in 56% of the years in which financial development has a 'below the mean' effect, we find that trade openness experiences a substantial 'above the mean' change.

Despite the fact that in the period since 1930 Brazil remained a closed economy (see Figure 3.B1 in the Appendix 2), international financial development is expected to have played a significant role in Brazil's economic growth. Abreu and Verner (1997) argue that from 1930-1980 Brazil had a unique foreign economic orientation, with bold export promotion policies and a rather closed domestic market. Campos et al. (2022) argue that exogenous increases in domestic financial development have a negative indirect effect on growth. On the contrary, higher U.S. interest rates are linked with a larger proportion of growth volatility. Therefore, international financial integration leads to higher growth. This is intuitive,

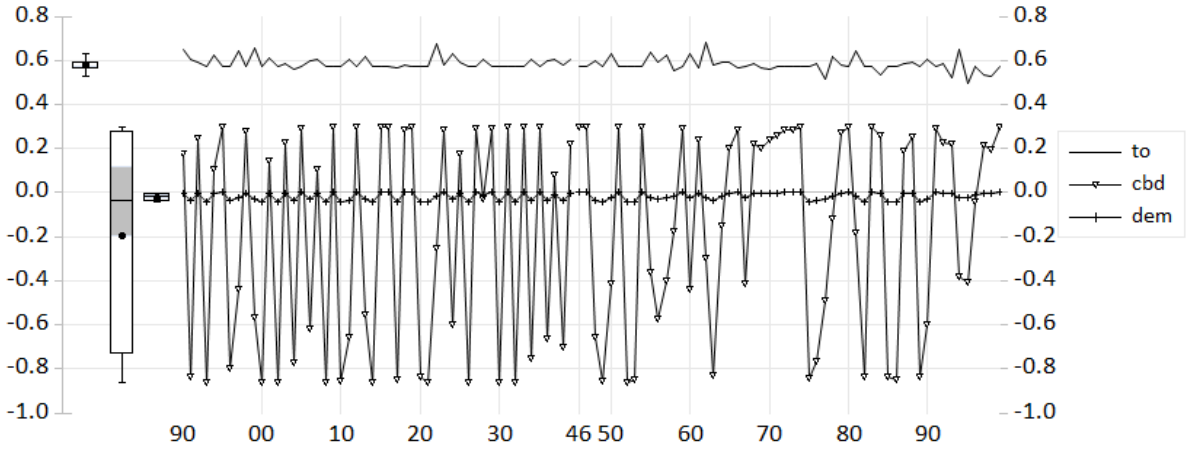
[30] Boxplots display the mean (•) and the median (—) for each variable as well as the shaded confidence intervals at 95% for the mean.

[31] This finding is really interesting given the results provided by Rajan and Zingales (2015).

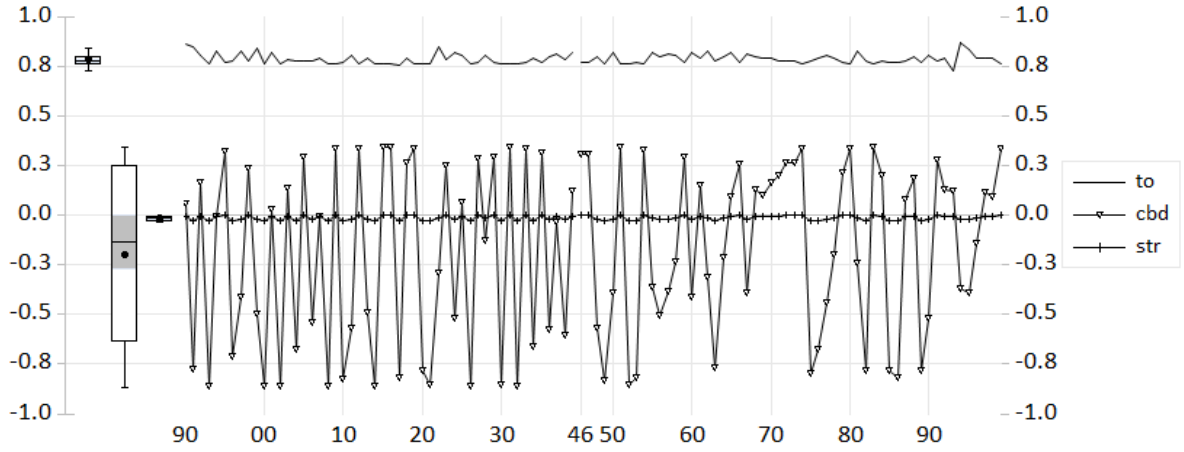
as reductions in the U.S. interest rate lead to a reduction of the price of money internationally, which in turn leads to reduced levels of risk.

As far as the level of γ (γ determines how smooth the change in the value of the logistic function is, see eq. 3.2) is concerned the change between the two regimes, that is from a relatively open to a relatively closed economy, is not so smooth, with the exception of legislative elections, where the transition is smoother (see Figure 3.5 below). Alternatively, the large value of γ indicates that the change between the two regimes is abrupt in the majority of the cases.

Figure 3.4. Time-varying Effects of Trade Openness (to), Financial Development (cbd) and Political Instability (Either dem Or str Or ls Or le) On Growth.

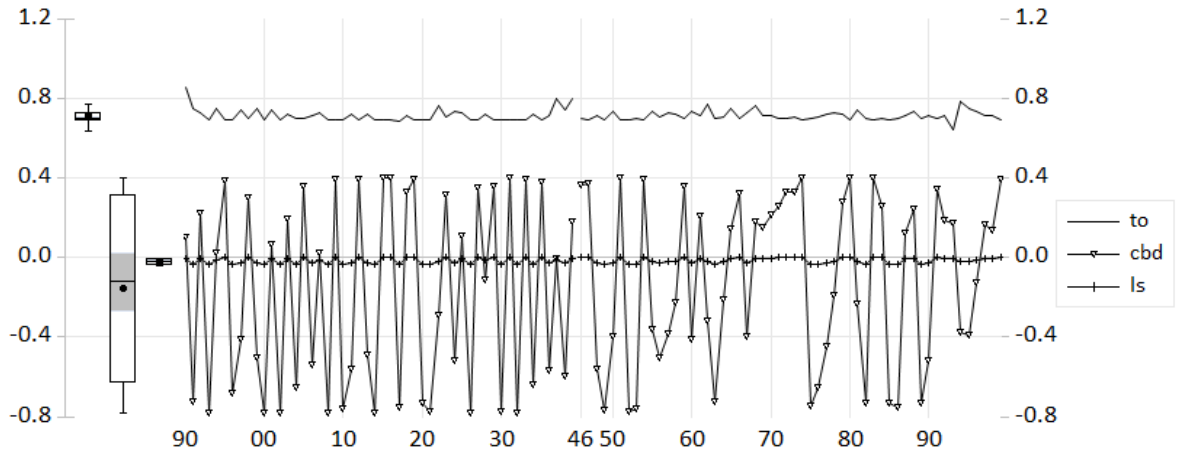


Year

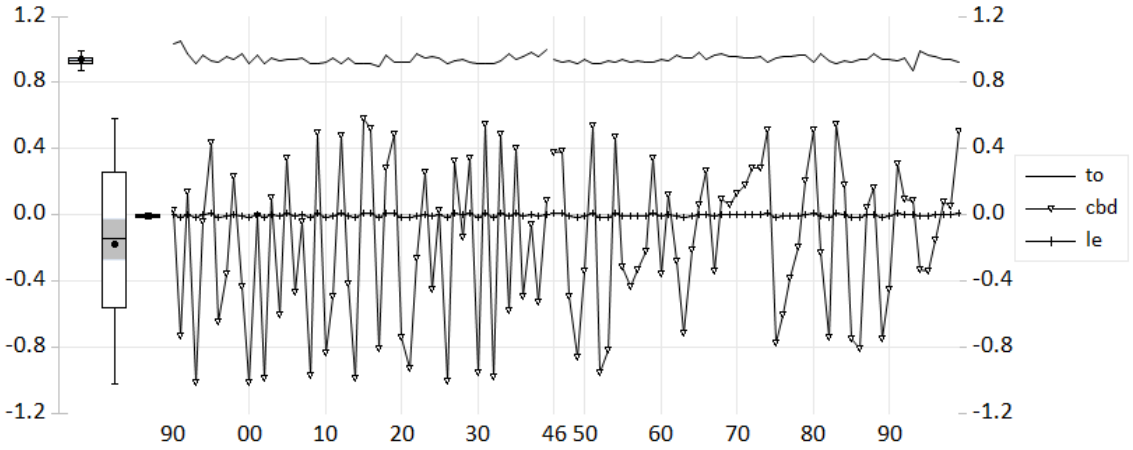


Year

Figure 3.4. Continued



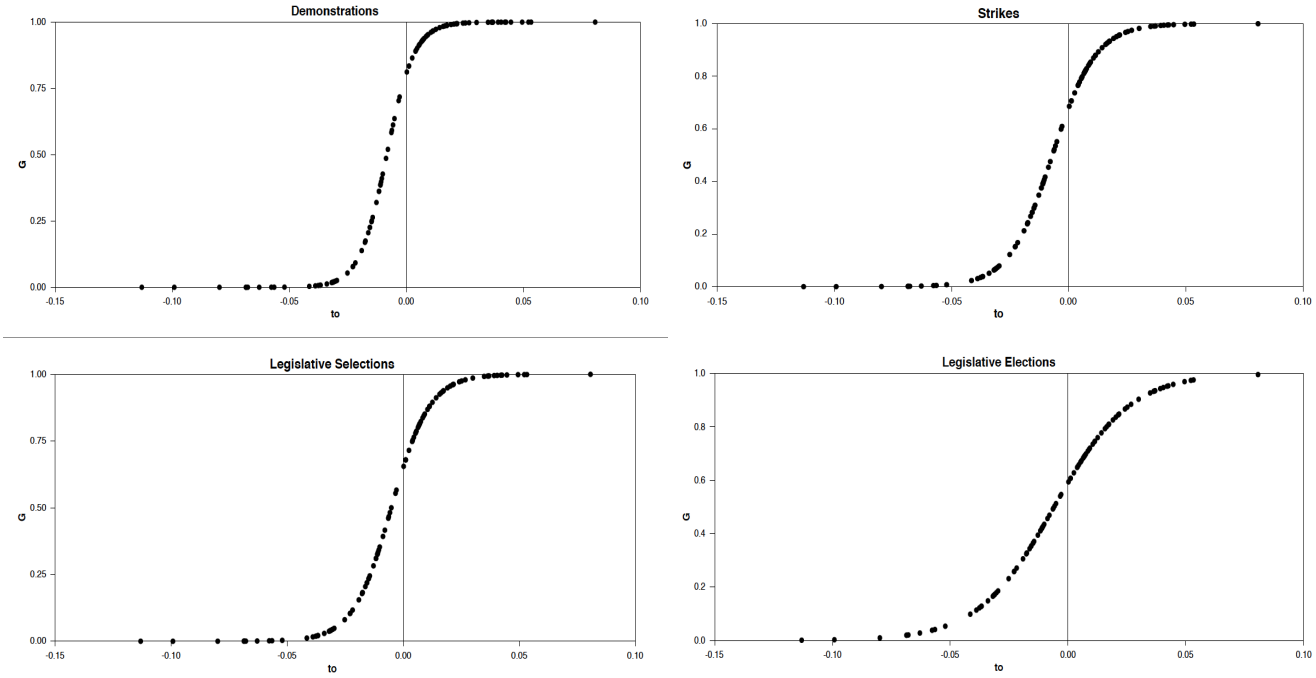
Year



Year

Notes: Boxplots display the mean (•) and the median (—) for each variable as well as the shaded confidence intervals at 95% for the mean.

Figure 3.5. Smooth Transition Function ($G(s_{t-d})$) vs Transition Variable (to_{t-4}).



Robustness Checks

To corroborate further our results we perform a battery of robustness checks. Even though we know from the work of Knack and Keefer (1995) and Rodrik et al. (2004) onwards that the institutions trump the contribution of geography and trade in explaining cross-country income differences over time, it is impossible to isolate the confounding effects of human capital as a competing channel that feeds directly into growth rates. Glaeser et al. (2004) show that poor countries tend to escape the poverty trap through human capital investment often pursued by benevolent dictators while Jeffery Sachs, Jared Diamond and his followers believe that geography makes all the difference. Relatedly, could it be that the informal instability variables partially capture the role of culture which many, starting with Max Weber and David Landes, believe makes all the difference by acting as a brake or filter on economic development?

To address the issue of omitted variable bias, we re-estimate the regressions from Table 4 by controlling for the effect of human capital formation using the average years of education (data obtained from Spruk, 2016b) and see whether controlling for human capital renders the effects of informal and formal instability weak, stronger or intact. Furthermore, to eliminate any direct confluence of political instability induced by adverse physical geography (for more details see Miguel et al., 2004) we consider the variation in rainfall (rain) as well as the annual temperature (temp), which serve as observable measures of climatic shock (data obtained from the World Bank). We find qualitatively similar results. In particular, our findings show a positive (negative) impact of the average year of education (variation in temperature) on economic growth, whereas the effect of both informal and formal political instability (on output) remains negative with either the same or slightly weaker magnitude. In addition, we detect a negative link between the variation of rain and growth, though statistically insignificant. However, due to the fact that the aforementioned data series are not reported since 1890 the models of Table 4 included significantly reduced number of observations[32].

Relatedly, a measure of culture would be beneficial to rule out the direct effects of culture on long-run growth. Although we are aware of the difficulty of such an easily tractable measure, we exploited the approach of McCleary and Barro (2006) and we searched for the fraction of the population that is Catholic as well as the immigration rate as rough proxies for the effects of culture, which have been one

[32] Results are available upon request.

of the defining characteristics of Brazil's economic and institutional history. However, the data available from the Brazilian Institute of Geography and Statistics (IBGE) were discontinued for both variables (for example the immigration rate is available from 1870 to 1975).

Discussion

In this subsection we will cross-validate our results with a country that has experienced similar magnitudes of political and institutional instability, such as Argentina as well as motivate our analysis with reference to recent negative trends or challenges for emerging market economies (EMEs) with respect to political instability. We will also discuss how our results speak to future growth outcomes for EMEs.

Campos and Karanasos (2008) and Campos et al. (2012) investigated the link between financial development, political instability and growth for Argentina from 1896 to 2000. Their findings show that (a) political instability has a negative effect on growth whereas (b) the financial development effects are negative in the short- but positive in the long-run (with the positive being substantially larger than the negative one). Our estimates for Brazil report (a) a strong negative effect of institutional instability on growth; (b) a mixed time-varying impact (in the short-run) of financial development on growth (with clearly positive and large effects on economic growth during the end of our sample). While it is important to check for the external validity of our results, especially among Latin America countries, yet we should point out that Argentina is unique in a way that no other country in the world since the Industrial Revolution went from riches to rags. Put differently, Argentina is an outlier.

EMEs have experienced diverse changes in their political stability with important implications for economic growth and business environments. While persistent and rising political instability has undermined confidence (consumer and investor) in countries such as India, Egypt and Ukraine, economies like Indonesia and Chile have seen growing capital inflows as a result of improvements in political stability and their business environments. For example, India recorded a low performance in both its political stability and business environment rankings (ranked 178th out of 203 countries in the Political Stability and Absence of Violence 2013 index and 142nd out of 189 countries in Doing Business 2015). Among the factors affecting the country's performance were poor governance, high disparities in rule of law, infrastructure deficits and corruption. Similarly, in Egypt, high political unrest such as demonstrations and strikes undermined business environment reforms. Egypt ranked relatively low in the Doing Business rankings, at 112th out of 189 countries in the 2015 report, compared to UAE's 22nd position (see Euromonitor International, 2014).

Meanwhile, the outlook does not look good. Political unrest and geopolitical conflicts are expected to remain in some EMEs. Overcoming the pandemic crisis, returning to more normal policies and dealing with the emerging food crisis will increase the challenges in rebuilding their economies. Our results in the case of Brazil (that is lower level of political instability promotes economic growth) highlight the importance of a stable political environment in boosting economic growth by tackling rising income inequalities, high unemployment and corruption.

Concluding, it is important to distinguish policy and reality, i.e. between de jure and de facto for trade openness and for financial development. In that way we could explore how different types of economic openness as well as different indicators capture the impact of openness on economic growth in different ways, see Gräbner et al. (2018)[33].

More specifically, Bataka (2019) argues that in overall globalization boosts economic growth in Sub-Saharan countries (SSA). However, distinction between de jure and de facto aspect indicates a positive economic growth impact of de jure globalization, whereas de facto impacts economic growth negatively. The study also finds that de jure political globalization has no effect on economic growth, while de facto political globalization hampers growth.

3.6 Conclusion

The objective of this chapter was to further our understanding of the dynamics of relationship between economic growth, financial development and political instability. This chapter revisits the growth-finance nexus using a new econometric approach and new and unique data set. The econometric approach we use, and that has been seldom used in this literature so far, is the logistic smooth transition model (LST).

[33] Though given the historical perspective of this paper this would be a real challenge due to lack of data.

Our unique data set contains annual data for Brazil from 1890 to 2003. The logistic smooth transition framework allows us to study the dynamics of this relationship over the long-run, to evaluate the intensity and direction of its main drivers over time, and to assess how smooth (or not) was the transitions we estimate.

Our main finding is that financial development has a time-varying effect on economic growth, which significantly depends on jointly estimated trade openness thresholds, whereas the effect of political instability (both formal and informal) is unambiguously negative. We show that the finance-growth nexus in Brazil intrinsically depends on political institutions and on the regime-switching factor, which we estimate to be trade openness. Differently from most of the previous literature, which reports a negative short-run relation between financial development and growth, we argue in favour of a mixed time-varying effect (in the short-run). As far as the time-varying results are concerned we detect at least three periods, where financial development has a clearly positive and large effect on economic growth, interestingly all towards the end of our time window. Our estimates also show that a positive impact of trade openness on growth but with interesting variation regarding their size and power. For example, we estimate weaker (although still positive) effects between 1929 and 1933 which correspond to the Great Depression. Finally, our parameter estimates suggest that the change between the regimes tends not to be smooth.

Although the study conducted a thorough survey, there were certain limitations worth mentioning. One such limitation is that the empirical evidence does not provide a definite account of the causal link between finance, institutions and growth since we do not exploit plausibly exogenous sources of variation in Brazil's long-run growth and do not report a research design that would allow us to exploit such channels. However, we have addressed the omitted variable bias issue in greater detail (see the analysis in Section 5). Furthermore, we have not completely ruled out endogeneity (given the interrelation of our variables, reverse causality - growth causing faster financial development or trade openness - and potentially confounding factors). Nevertheless, the concern is greatly alleviated (with careful identification strategies and the lagged estimations) to the extent that our regressions yield consistent results. In addition, due to the historical scope of this chapter, certain factors, such as culture, which potentially directly affect economic growth could not be considered due to the unavailability of data.

Future studies should investigate the link between political instability and economic growth in a panel of developing countries. A simulation analysis on how growth rate would have been in the absence of some shocks of instability as well as considering the possibility of more than two regimes would clearly represent progress and is something we feel future research should try to address.

Appendix 2 for "Financial Development, Political Instability, Trade Openness and Growth in Brazil: Evidence from a New Dataset, 1890-2003"

Table 3.A1. Descriptive Statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
Growth Rate of the Level of GDP (GDP)	0.04	0.05	−0.12	0.29
Financial Development	−0.001	0.04	−0.24	0.25
Trade Openess	−0.001	0.03	−0.11	0.08
Informal Political Instability				
Anti-Government Demonstrations (dem)	0.38	0.88	0	5
General Strikes (gs)	0.22	0.48	0	2
Formal Political Instability				
Legislative Selections (ls)	1.84	0.53	0	2
Legislative Elections (le)	1.77	0.80	0	3

Table 3.A1 provides descriptive statistics on growth, financial development, trade openess and a sampling of informal and formal political instability measures. More specifically it records the mean, the standard deviation as well as the minimum and maximum for Brazil for the entire sample period (1890-2003).

Table 3.A2. Zivot and Andrews (1992) Unit Root Tests With Breaks

	Type of Break		
Variable	With Intercept	With trend	Both
gdp	-10.77^{***} (1981)	-10.37^{***} (1973)	-10.72^{***} (1981)
cbd	-12.94^{***} (1906)	-13.87^{***} (1906)	-14.34^{***} (1919)
to	-13.85^{***} (1909)	-13.81^{***} (1916)	-14.09^{***} (1920)
dem	-9.76^{***} (1984)	-9.58^{***} (1981)	-9.66^{***} (1984)
str	-9.41^{***} (1978)	-9.15^{***} (1988)	-9.82^{***} (1978)
ls	-7.09^{***} (1930)	-6.75^{***} (1933)	-7.58^{***} (1946)
le	-4.78^{*} (1940)	-3.72 (1971)	-4.80^{*} (1940)

Notes: ***,* indicate significance at 1% and 10% level respectively. Columns 2, 3 and 4 show estimated t-statistics when we account for breaks in the intercept, in the trend or both. The numbers in parentheses mark break points. Notably only the measure of *le* is unit root when a break in the trend is permitted.

Table 3.A3. Linearity Testing, Using Commercial Bank Deposits (cbd) as the Transition Variable.

Variable	Linearity LM_2	d-delay parameter
dem	0.25	4
str	0.03	4
ls	0.07	4
le	0.20	4

Notes: Column 2 represents p-values of the linearity rejection. Based on Teräsvirta (1994) most of the cases reject linearity at either 5% or 10%.

Table 3.A4. Linearity Testing, Using Economic Growh (gdp) as the Transition Variable.

Variable	Linearity LM_2	d-delay parameter
dem	0.30	4
str	0.09	4
ls	0.28	4
le	0.40	4

Notes: Column 2 represents p-values of the linearity rejection. Based on Teräsvirta (1994) most of the cases reject linearity.

Table 3.A5. Postestimation Analysis of Models of Table 4.

Variable	$F-statistic$	LB
dem	0.001	0.220
str	0.002	0.280
ls	0.000	0.160
le	0.000	0.210

Notes: The table reports the F-statistic and the Ljung and Box (LB) statistic that tests remaining residual autocorrelation. Numbers reported are p-values.

Table 3.A6. Average Marginal Effect of Trade Openness, Political Instability and Financial Development.

Variable	to	pi	cbd
dem	0.58	−0.02	−0.19
str	0.79	−0.01	−0.20
ls	0.71	−0.02	−0.15
le	0.94	−0.01	−0.17

Notes: The table reports the average marginal effects obtained from eq.3, 4 and 5 for trade openness (to), political instability (pi) and financial development (cbd).

Figure 3.A1. Other Measures of Democracy and Institutional Development

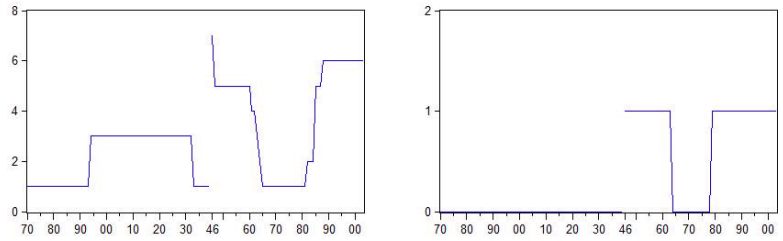


Fig. A1.a: Executive Constraints

Fig. A1.b: Democracy Dichotomous

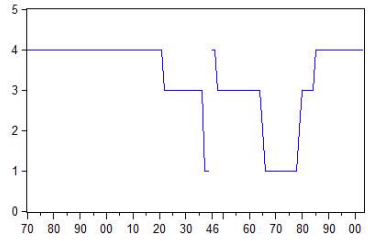


Fig. A1.c: Party Ban

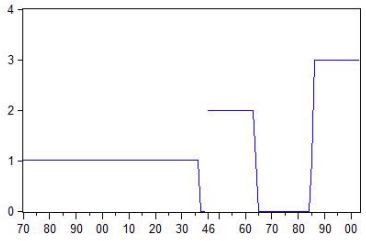


Fig. A1.d: Freedom from Political Killings

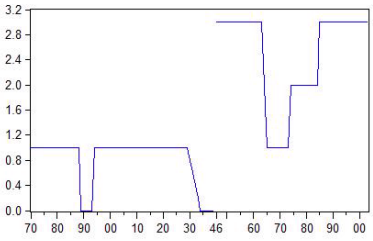
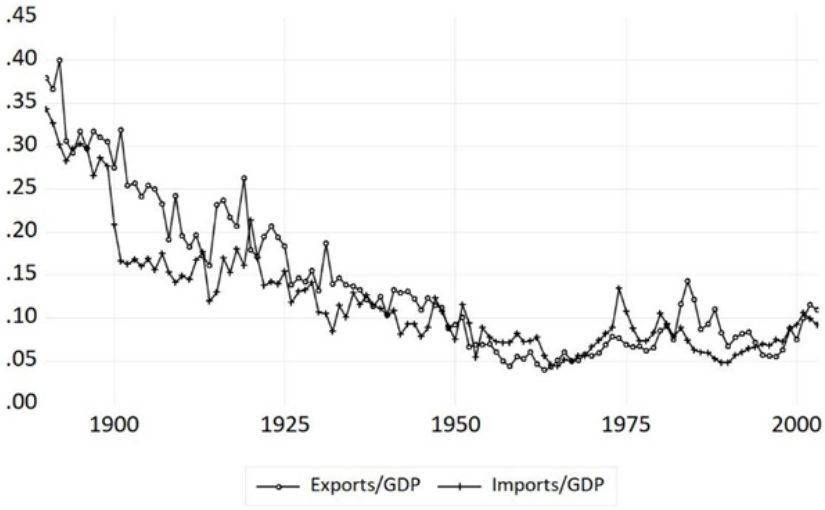


Fig. A1.e: Competitiveness of Executive Recruitment

Figure 3.B1. Exports and Imports as a Share of GDP Over Time



Chapter 4

Contractionary and Expansionary Fiscal Multipliers in the U.S.

4.1 Introduction

Analyzing the fiscal multiplier - or suite of multipliers how government spending or taxation affects economic activity - remains an active research area. Its policy implications are great - especially during recessions or when monetary policy seems less able to stimulate due to the 'zero lower bound' problem.[34] It is one of the first concepts given to students in macroeconomics although it is still discussed conceptually and empirically; though views are increasingly converged, there is no full consensus yet. (see e.g., Ramey, 2011, 2019). A better appreciation of the empirical magnitude of fiscal multipliers and their drivers is essential for policy goals as well as theoretical clarity.

This chapter continues this investigation. We estimate the output effects of unexpected government spending shocks using quarterly US data from 1986 to 2017.

Our contribution is to estimate time-varying fiscal multipliers conditional on different states of the business cycle by smooth-transition estimation, characterising multipliers by the sign of the spending shocks. Spending shocks are identified through professional forecasts of the growth in government spending. Thus, the chapter rests on three key features; although individual aspects exist in various precedents, the combination of all three is novel. We discuss each next.

The first, and main, feature is to decompose the fiscal policy shocks into positive and negative, and characterise multipliers accordingly. The rationale is that positive and negative shocks correspond naturally to expansionary and contractionary fiscal policy (specifically spending). Basic theory leads us to expect numerically different effects, as contractionary policy may be characterised more by the textbook 'Keynesian' multiplier, whereas expansionary policy is characterised more by the'neoclassical' type; we expand below. The bottomline is that the Keynesian multiplier is more germane to fiscal contractions and is likely to be more sizeable than the neoclassical multiplier, which is germane to fiscal expansions. Standard practice pools expansions and contractions, potentially biasing the estimates. The effects of contractions, especially, are likely to be underestimated. This is because the multipliers are estimated with reference to normal fiscal experiments, which are mostly expansions, and are likely to have lower effects than contractions. Thus, when the latter actually happen, they are likely to have stronger effects than predicted. Indeed, Blanchard and Leigh (2013, 2014) and Fatás and Summers (2018) find a significant negative correlation between the forecast error of GDP growth (actual minus forecasted) and forecasted fiscal consolidations in the early post-recession years (2010-11) when various countries in Europe and elsewhere engaged in fiscal consolidations. The bias in the forecast error (which did not exist before the period) suggests that output fell more than expected (the multipliers were greater than previously estimated) during recessions and during negative fiscal shocks.[35] These arguments and findings are consistent with both state-dependency of the multipliers and potentially stronger effects of fiscal consolidations.

There are a couple of valuable precedents distinguishing spending multipliers by the sign of the shock. In very recent work, Barnichon, Debortoli and Matthes (2022) show that expansionary (contractionary) shocks are characterised by a multiplier substantially below (above) 1. In addition, these multipliers are state-dependent. They find the contraction multiplier to be largest in recessions| but uncover little evidence of state-dependence for the expansionary multiplier. The authors interpret these results as consistent with a theoretical New Keynesian model with borrowing constraints and downward wage rigidity. The asymmetry in the multipliers is consistent with basic theory explained below; however, the

[34] The ongoing Covid-19 pandemic has further highlighted the relevance of fiscal policy and the widely adopted fiscal support measures. However, as the paper was substantially written during 2021, while the episode was ongoing, its analysis is best left to future work.

[35] The bias also suggests that the fiscal multipliers were underestimated when the fiscal consolidations were designed. Gornicka et al. (2019) confirms this and also finds that the European Commission, in particular, gradually adjusted upwards its estimates of the multiplier in the light of experience.

results on state-dependence are somewhat counter-intuitive, as contractions are the types of shock that face less supply constraints, therefore their difference should be minimal between states of the economy; in sharp contrast, the expansionary shocks should vary, as they are the ones that will encounter the most binding supply constraints. Closest to our own analysis, Riera-Crichton, Vegh and Vuletin (2015) aim to disentangle the direction of the spending shocks (expansionary-contractionary) from their timing (the stage of the cycle at which they apply). They find that the multiplier is larger (above 1) in recessions while essentially insignificant in expansions. However, when they differentiate by the sign, they find expansionary shocks to be large (above 1) while contractionary ones are insignificant. Again, in the light of basic theory, this result is rather strongly counterintuitive. Thus, the importance of the sign of the government spending shock for the multiplier has now been flagged up; but the line of research that these innovative efforts open requires further investigation. The main contribution of this chapter is in this direction: The differential between the effects of fiscal expansions and contractions is the key question we ask. [36]

Basic theory provides helpful intuition: The textbook Keynesian spending multiplier is of the form $dY/dG = 1/(1 - MPC) > 1$, where $0 < MPC < 1$ is (the presumed fixed) marginal propensity to consume out of current income; variants include the tax and balanced-budget multipliers, or the spending multiplier with variable taxation, imports and similar extensions. As taught in elementary courses, this spending multiplier is higher than unity. The key point is that this suite of multipliers is entirely demand-side based (hence 'Keynesian'); supply-side restrictions such as capacity constraints, increasing marginal disutility of labour (manifesting itself in increasing wages, e.g. overtime rates as the normal output is exceeded), rising costs of energy or materials and similar considerations, are entirely absent. This is more likely to apply during recessions than expansions. Another implication that has received less attention is that this will be true to a larger extent during fiscal contractions than during expansions; this is because during contractions, the relevant supply constraints are less: it is more difficult to build capacity than to reduce it.

Another line of thinking on the multiplier is the neoclassical multiplier; see Hall (2009), Mulligan (2011) and Woodford (2011). Almost symmetrically, this multiplier is based entirely on supply-side considerations: Consumption and labour supply are determined by (static) optimisation. Both output and labour markets clear such that there cannot be any excess supply of either output or labour; this immediately suggests that there is less scope for a fiscal expansion to affect output as demand is not lacking. As a result, this spending multiplier is less, between zero and unity. The intuition is the following: As government spending rises, with a given output, consumption is crowded out. As the marginal utility of consumption rises, so must the marginal utility of leisure, which implies less leisure and more hours of labour supply.[37] The higher employment allows extra output to be produced. But consumption will fall: this is what motivates the individual to work harder in the first place. This argument is at the heart of the result that output rises but less than government spending. As a corollary, a fiscal expansion is less likely to increase welfare or indeed, by reducing private consumption, to be politically acceptable. Thus, the neoclassical multiplier captures disutility-of-work considerations, and in broader terms all capacity constraints. Demand as an autonomous consideration is absent. Extending previous arguments, it is more likely to apply during booms than recessions, a mirror image of the state-dependency of the 'Keynesian' multiplier. Equally, it is more likely to be true during a fiscal expansion than a contraction.

Multipliers in the intertemporally optimising DSGE models (Gali, Lopez-Salido and Valles, 2007; Cogan et al., 2010) generally blend the two lines of argument; while neoclassical in their core, the Keynesian element in those models arises from frictions such as price/wage stickiness and/or the fact that some households are liquidity-constrained and hence consume a fraction of their current, rather than permanent, income ('rule-of-thumb' consumers). Some of these arguments are not inconsistent with our basic hypothesis: If the households that are able to optimise intertemporally behave in the way suggested by the neoclassical multiplier, the constrained households behave according to the Keynesian one. If the fraction of the constrained households rises during a recession, then in such periods, we should

[36] Tenreyro and Thwaites (2016) forms an interesting background to both previous literature on fiscal policy and to the present work, as it finds (a) that monetary policy effects are state-dependent, and in fact weaker during recessions (in sharp contrast to what has been found with regard to fiscal policy); and (b) that monetary contractions have stronger effects than expansions (paralleling our results on fiscal policy).

[37] This can be seen from the equality between the marginal substitution and marginal transformation between leisure and consumption; in obvious notation: $U_l/U_c = w$.

be seeing multiplier values move towards the spectrum predicted by Keynesian arguments. Financial frictions may also imply state dependency of fiscal multipliers (e.g., Canzoneri, Collard, Dellas and Diba, 2016). But none of these features implies a difference between the magnitudes of fiscal contractions and expansions. Bhattarai and Trzeciakiewicz (2017) allows for a variety of fiscal shocks (public consumption, investment and transfers) and finds a public consumption multiplier of about unity on impact, and decreasing thereafter; the multipliers of public investment spending are higher. The strength of theory-based DSGE models is their rich structure, potentially allowing a clearer understanding on the effects of shocks and the channels by which they arise. However, as Ramey (2019) argues, the rich structure is a double-edged sword: Estimation relies on strong assumptions about model structure and the time series processes of shocks. As a result, this line of investigation should be complemented by other approaches to estimation, such as the time series approach that we follow here.

Echoing a neoclassical line of reasoning, Hall (2009) estimates the government expenditure multiplier to be between 0.5 and 1. In a more Keynesian spirit, the wide-ranging review of empirical studies by Ramey (2011) leads her to suggest a plausible range for the spending multiplier of 0.8 to 1.5; her more recent survey (Ramey, 2019, Table 1), however, seems to suggest estimates mostly lower than unity. Blanchard and Perotti (2002) present evidence that a deficit-financed government spending increase that persists for four quarters raises output less than one-to-one but persistently (for up to 20 quarters ahead). In contrast, Mountford and Uhlig (2009) find a cumulative deficit-financed spending multiplier that is below unity, and when one takes into account the tax rise that will inevitably arrive later on in order to repay the debt, there is an output loss (in present-value terms). Instead, they find more encouraging results for a deficit-financed tax cut.

Using historical U.S. data covering multiple large wars and deep recessions, Ramey and Zubairy (2018) find that the multiplier is lower than unity even in conditions of slackness and recession; the only condition that might push multipliers above unity seems to be interest rates stuck at the zero lower bound. Gali, Lopez-Salido and Valles (2007) find a government spending multiplier on output of 0.78 on impact and of 1.74 after 8 quarters. Cogan et al. (2010) predicts that a permanent rise in fiscal expenditures equal to 1% of GDP leads to a 1% rise in GDP in the 1st quarter, falling to 0.6% at the 8th quarter and to a 0.4% rise after four years. Blanchard and Leigh (2014) argue that they are plausibly between 0.9 to 1.7. The follow-up study of Fatás and Summers (2018) additionally finds the mutlipliers to be very persistent: A typical fiscal consolidation in Europe during the period 2009-11 that led to a decrease of 1% in GDP on impact led to changes of greater than 1% by 2015 and was projected to lead to a decrease of 2% in GDP by the year 2021. Zubairy (2014) finds the government spending multiplier to be marginally above unity (1.07), largest on impact. Our motivation is that there is much gain to be had in estimation by differentiating between the effects of positive and negative fiscal shocks.

The second key feature of this study is that fiscal multipliers are time-varying, estimated by innovative methodology. It is now established that the size of the multiplier depends on the state of the economy, particularly on whether output is below or above normal. The general finding is that the multiplier is stronger in recessions rather than expansions; relevant contributions here include Auerbach and Gorodnichenko (2012, 2013, 2017), Fazzari, Morley and Panovska (2015), Jordà and Taylor (2016), Caggiano, Castelnuovo, Colombo and Nodari (2015), Riera-Chricton et al. (2015) and Ramey and Zubairy (2018). It is easy to show (but often foregone) that this finding is consistent with the standard macroeconomic reasoning expounded above. We capture state dependence by using 'smooth transition' estimation, whereby the parameters of the lag polynomial are state-dependent. In addition, the state of the economy is not binary (recession or expansion) but a linear combination of the two states, or regimes; furthermore, we allow this linear combination to be time-varying. Only a few papers (Auerbach and Gorodnichenko, 2013; Ramey and Zubairy, 2018; and Tenreyro and Thwaites, 2016, for monetary policy) have hitherto used this method and we follow them. Furthermore, we use the local projections method (Jordà, 2005) in order to estimate impulse responses. We report two sets of results, the (present value of the) impulse responses of spending shocks on output and the multipliers suggested by Mountford and Uhlig (2009) and Ramey (2019).

The third key feature concerns the specification of the spending shock. Much of the literature extracts the government spending shocks from a VAR using one of the available identification procedures; a prominent example is Blanchard and Perotti (2002). However, all such identification procedures remain

debatable.[38] We therefore choose to follow the alternative approach of Auerbach and Gorodnichenko (2012, 2013, 2017) and Riera-Chricton et al. (2015) in employing professional forecasts of the growth in government spending contained in the Survey of Professional Forecasters (SPF) compiled by the Federal Reserve Bank of Philadelphia; we then compute the spending (growth) shock as actual minus forecast of the government spending growth rate (see e.g. House, Proebsting and Tesar, 2020, for a recent such example). We present an additional two variants of the shock thus compiled, by filtering out any predictable component due to correlation with (detrended) output or due to autocorrelation.

The chapter is organised as follows. Section 4.2 and 4.3 describe our data and estimation methods, while Section 4.4 describes the results. To pre-amble, we find systematic differences in the estimated coefficients of the main regression when that is applied separately to the two types of shock. Also, the results do suggest that the multipliers resulting from contractionary shocks are higher than those of the expansionary shocks, partlicularly in the shorter run (an horizon of four quarters). Furthermore, the difference in the multipliers that show the ouput effects of contractionary and expansionary shocks (what we call below the PVIR-FMs) are uniformly significant. The last Section 4.5 concludes.

4.2 Data Sources and Variables

We use U.S. data derived from the OECD Economic Outlook; one exception is the data on the government debt-GDP ratio (d_t), obtained from the Bank for International Settlements (BIS). Furthermore, as mentioned, forecasts of government spending growth (GSF_t) were obtained from the Federal Reserve Bank of Philadelphia's Greenbook Data Set: Survey of Professional Forecasters (SPF). These forecasts are available from 1986.[39] The data is quarterly from 1986Q1 to 2017Q4. Specifically, we use the following variables:

Y_t: Real gross domestic product (GDP). From this variable, we obtain:

$g_t^Y \equiv \Delta Y_t / Y_{t-1}$, is the real GDP growth rate where Δ is the difference operator (i.e., for any variable X_t, $\Delta X_t \equiv X_t - X_{t-1}$).

$z_t \equiv 100(logY_{t+3} - logY_{t-4})/7$ is a smoothed growth rate of output, used to identify the states of the cycle (expansion or recession) that we use in the transition function of the estimation procedure below.We characterise low (high) values of z_t as Recession (Expansion).

y_t: detrended output, deviation of $logY_t$ from potential log real GDP; the latter is constructed applying the Hodrick-Prescott (1997) filter on $logY_t$, with $\lambda = 10,000$ so as to alleviate noise added by extreme events such as the recession of 2008.

d_t: The government debt-GDP ratio (source: BIS).

GGC_t and GGI_t: real government consumption and government investment, respectively. The total real government spending (G_t) is constructed as $G_t \equiv GGC_t + GGI_t$. We then construct the growth rate of real government spending, $g_t^G \equiv \Delta G_t / G_{t-1}$.

I_t^{ST} and I_t^{LT}: the short- and long-term nominal interest rates, respectively.

GSF_t. Forecast of the growth rate of government spending during t one period in advance $(t-1)$ (source: SPF).

$FE_{t|t-1} \equiv g_t^G - GSF_t$ is the forecast error (actual minus the forecast) of the growth rate of government spending. In order to differentiate between positive and negative spending shocks, we differentiate $FE_{t|t-1}$ by sign, i.e. we define:

$$FE^+_{t|t-1} \equiv \begin{cases} FE_{t|t-1} & \text{if } FE_{t|t-1} \begin{cases} > 0 \\ < 0 \end{cases} \\ 0 \end{cases}$$

$$FE^-_{t|t-1} \equiv \begin{cases} FE_{t|t-1} & \text{if } FE_{t|t-1} \begin{cases} < 0 \\ > 0 \end{cases} \\ 0 \end{cases}$$

[38] See e.g. Auerbach and Gorodnichenko (2017) and Ramey and Zubairy (2018) on criticisms of such procedures. Identification of tax schocks, on the other hand, raises if anything even more serious identification issues, hence tax-based fiscal policy is outside the scope of this paper. Our results should therefore be interpreted as debt-financed spending multipliers, i.e. taking taxation as given. See Alesina, Favero and Giavazzi (2019) for an review of issues and results comparing spending and tax-based fiscal consolidations.

[39] The OECD Economic Outlook, released twice a year, contains forecasts of various macroeconomic variables, including government spending. However, we eschew these forecasts as their semi-annual availability would require questionable interpolations in order for them to be used with quarterly data.

As positive (negative) numbers indicate that government spending was higher (lower) than the professional forecast of the same made one period earlier, we refer to these as expansionary ($FE^{+}_{t|t-1}$) and contractionary ($FE^{-}_{t|t-1}$) government spending shocks. We also indicate all shocks by $FE^{ALL}_{t|t-1}$; by definition, $FE^{ALL}_{t|t-1} = FE^{+}_{t|t-1} + FE^{-}_{t|t-1}$. Our government spending shock therefore is : $gss_t = FE^{ALL}_{t|t-1}$, $FE^{+}_{t|t-1}$, $FE^{-}_{t|t-1}$; it takes alternatively all, the positive, or the negative values of $FE_{t|t-1}$. Accordingly, we report separate results based on all shocks pooled together, and the positive and the negative shocks separately. Furthermore, considering that $FE_{t|t-1}$ may still contain predictable elements as argued by Ramey (2011), we improve its quality by (a) filtering out any correlation with y_t and (b) as the residuals from an AR(1) process of $FE_{t|t-1}$ itself. We use these two transformations (separately) as variants of the shock; we give more details below. We follow the same procedure in distinguishing between positive and negative shocks of both variants of the shock.

4.3 Econometric Methodology

Our methodology follows Auerbach and Gorodnichenko (2012, 2013) and Ramey and Zubairy (2018). We employ the Jordà (2005) local-projections method to simplify estimation of the Impulse Response Functions of various shocks. In addition, we allow state-dependence of the parameters of the lag polynomial. There is smooth (rather than binary) transition between states or regimes: The transition function depends on the state of the economy and produces a time-varying linear combination of the parameters across the two states. One key advantage of this methodology over the more standard binary regime method is that the latter could potentially make the estimates unstable and less precise in the case of too few observations in a particular state (Auerbach and Gorodnichenko, 2013). Accordingly, we estimate a set of regressions for 8 quarters ($h = 0, 1, 2, 3, \ldots, 7$) as follows:

$$g^{Y}_{t+h} = F(z_t)(\alpha^{Y}_{R,h} + \psi^{Y}_{R,h}(L)X_{t-1} + \beta^{Y}_{R,h} gss_t) + (1 - F(z_t))(\alpha^{Y}_{E,h} + \psi^{Y}_{E,h}(L)X_{t-1} + \beta^{Y}_{E,h} gss_t) + \varepsilon_{t+h}, \quad (4.1)$$

$$F(z_t) \equiv \frac{\exp(-\gamma z_t)}{1 + \exp(-\gamma z_t)}, \gamma > 0 \quad (4.2)$$

where $X_t = [g^{Y}_t \;\; g^{G}_t \;\; d_t \;\; I^{ST}_t]'$ is the vector of the explanatory variables, all defined above.[40] The model estimates lag (L) polynomials of X_{t-1}. $F(z_t)$ is the transition function, on which more below. In common with state-dependent estimation, we obtain two sets of estimated coefficients, depending on the state (or regime) i, $i = R, E$, where R is recession and E is expansion. Furthermore, $\alpha_{R,h}$ and $\alpha_{E,h}$ are time effects, $\psi_{R,h}(L)$ and $\psi_{E,h}(L)$ are lag polynomials of order 4 (as usual with quarterly data in order to filter out any residual seasonality), and the $\beta_{R,h}$, $\beta_{E,h}$ coefficients estimate the response of X_{t+h} to a shock at time t. ε_{t+h} is an error term; we apply the Newey-West (1987) correction to address the issue of serial correlation in this error term, induced by the successive leading of the dependent variable. In line with smooth transition modelling, we obtain a time-varying linear combination of the estimates of the parameters in the two states, based on the smoothly-changing weight $0 < F(z_t) < 1$, which can be interpreted as the probability of the economy being in a particular state (R or E). Following again Auerbach and Gorodnichenko (2012, 2013) and Ramey and Zubairy (2018), we use the smoothed output growth rate (z_t) as an indicator of the state of the economy: recession (R, with low z_t and high $F(z_t)$) and expansion (E, the opposite).[41] Given the difficulty in estimating the γ parameter, Granger and Teräsvirta (1993) suggest imposing fixed values. We set $\gamma = 1.5$ so that the economy does not spend more than 20 percent of the time in a recession. This is consistent with the National Bureau of Economic Research (NBER) business cycles dates regarding the duration of the business cycles in the U.S., showing that 21 percent of the time since 1946 has been characterised by recession. Using: $gss_t = FE^{ALL}_{t|t-1}$, $FE^{+}_{t|t-1}$, $FE^{-}_{t|t-1}$, we estimate the following equation:

[40] As a check, we also used the long interest rate (I^{LT}_t) but the results were essentially identical; they are available on request.

[41] We also tested a variant of the state of the economy based on detrended output (y_t). The findings were very similar and hence not reported.

$$g^Y_{t+h} = F(z_t)(\alpha^Y_{R,h} + \psi^Y_{R,h}(L)X_{t-1} + \beta^{Y+}_{R,h}FE^+_{t|t-1} + \beta^{Y-}_{R,h}FE^-_{t|t-1}) + \tag{4.3}$$
$$+ (1 - F(z_t))(\alpha^Y_{E,h} + \psi^Y_{E,h}(L)X_{t-1} + \beta^{Y+}_{E,h}FE^+_{t|t-1} + \beta^{Y-}_{E,h}FE^-_{t|t-1}) + \varepsilon_{t+h} \ ,$$

Accordingly, we differentiate the β-coeffients as $\beta^{Y+}_{i,h}$ and $\beta^Y_{i,h}$, for $i = R, E$. In the case of positive (negative) shocks being considered separately, we have $\beta^{Y+}_{i,h} \neq 0$ and $\beta^Y_{i,h} = 0$ (resp., $\beta^{Y-}_{i,h} \neq 0$ and $\beta^{Y+}_{i,h} = 0$). When all shocks are pooled together, then the equality $\beta^{Y+}_{i,h} = \beta^{Y-}_{i,h}$ is imposed.

4.3.1 Multipliers

Before proceeding, it is useful to digress briefly on what channels of propagation the spending shocks may follow. Consider a spending shock, δG_t, where δ is a deviation from the reference path of government spending (G_t) caused by the shock at time t. Whether a Keynesian or neoclassical multiplier applies, this will induce the following three effects: Firstly, a direct effect of δG_t begins by affecting output contemporaneously, $\delta G_t \rightarrow \delta Y_t$, and this will affect future output through the persistence and lag mechanisms in output (current income affecting future consumption or investment, current investment affecting future investment through 'time-to-build' effects, etc); schematically; $\delta Y_t \rightarrow \delta Y_{t+h}$. Secondly, there is an indirect effect, as some government spending is proportional to output and thus endogenous and not discretionary, therefore there may be a feedback effect from this spending to output. Schematically, if T_t is taxation, we have: $\delta Y_{t+h} \rightarrow \delta T_{t+h} \rightarrow \delta G_{t+h} \rightarrow \delta Y_{t+h}$. The last link appears because the balanced-budget multiplier tells us that the net effect of taxation and spending is non-zero (expansionary). Thirdly, another indirect effect may be present as current government spending may be autocorrelated, such that $\delta G_t \rightarrow \delta G_{t+h}$. This may be because current government spending affects the future one, again because of 'time-to-build' effects, this time in relation to public infrastructure; if so, the autocorrelation of δG_{t+h} will be positive.

However, this autocorrelation may be negative if there is a 'mean reversion' in spending growth, i.e. shocks of a certain sign are likely to be followed by shocks of the opposite sign, and government spending returns to normal after a shock. To pre-amble, this effect shows up quite strongly in our data. Whatever the autocorrelation in government spending, future changes in the latter will affect output (even though they are anticipated at the time they happen); schematically; $\delta G_{t+h} \rightarrow \delta Y_{t+h}$. In a nutshell, the original unit unexpected shock δG_t induces changes in current and future output via a number of channels. All these effects are included in the estimated impulse responses of the original shock, to be indicated by $\frac{\delta Y_{t+h}}{\delta G_t}$. We first estimate the present value of the impulse responses, $m_t \equiv \sum \frac{\delta Y_{t+h}}{\delta G_t}(1+r)^{-h}$, over two horizons of 4 and 8 quarters, as the horizon of 8 quarters seems to be the one over which most of the effects of fiscal policy have manifested themselves, in much of the literature. We call this the 'Present-Value Impulse Response - Fiscal Multiplier' (PVIR-FM). It is the multiplier that measures the 'pure' output effect, and is therefore our primary focus.

Part of the literature is focused on the question whether a fiscal shock elicits a greater response on output that is greater (or not) than the government spending shock itself. In this regard, Mountford and Uhlig (2009) and Ramey (2019) propose the ratio $\frac{\sum \delta Y_{t+h}(1+r)^{-h}}{\sum \delta G_{t+h}(1+r)^{-h}}$, i.e. the ratio of the present values of output responses (output deviations from baseline) to that of spending deviations from baseline. This information is useful as a measure of financial efficacy of the fiscal shock, i.e. as comparison of the output gain to the total fiscal cost involved in generating it. In this spirit, we present the difference:

$$M_t \equiv \sum(\tfrac{\delta Y_{t+h}}{\delta G_t})(1+r)^{-h} - \sum(\tfrac{\delta G_{t+h}}{\delta G_t})(1+r)^{-h}$$

again over 4 and 8 quarters, and call it the 'Financial Efficacy Coefficient - Fiscal Multiplier' (FEC-FM). [42] This coefficient gives the rise of output over fiscal spending, therefore it also has the interpretation as the rise of private spending (or crowding-in) following the shock (in present-value terms).

[42] We present the difference percentage changes in output and fiscal spending as taking the ratio of deviations involves very small magnitudes of the denominator that destabilises the ratio.

4.3.1.1 Present-Value Impulse Response - Fiscal Multiplier (PVIR-FM)

The spending multiplier measures the discounted cumulative impact in $ of an unexpected shock in public spending equal to $1 at time t on output over an horizon H, i.e.:

$$m_t \equiv \sum_{h=0}^{H-1} (\frac{\delta Y_{t+h}}{\delta G_t})(1+r)^{-h}$$

where, it should be recalled, Y_t is real GDP, δY_{t+h} is the deviation in output from baseline due to the fiscal shock, with $\bar{Y}_{t+h}$being baseline output (in the absence of shocks), δG_t is a unit, unexpected government spending shock at t and $r > 0$ is the real interest rate, assumed constant. The horizon is H=4,8 (quarterly data).

Both real GDP and government spending enter our empirical specification as growth rates, i.e. g_t^Y and g_t^G, and it should be recalled that the fiscal shock is actual minus expected growth of fiscal spending, $gss_t \equiv g_t^G - GSF_t \equiv \delta g_t^G$. From this, the shock in levels is obtained by noting that $\delta G_t / G_{t-1} \equiv \delta g_t^G \equiv gss_t$. Furthermore, since from basics we have: $Y_{t+h} = \left\{ Y_{t-1} \prod_{s=0}^{h} \left(1 + g_{t+s}^Y\right) \right\}$, we calculate the effect of a given shock on future output by cumulating the effect on future output growth rates:

$$\delta Y_{t+h} = \delta \left\{ Y_{t-1} \prod_{s=0}^{h} \left(1 + g_{t+s}^Y\right) \right\} = Y_{t-1}(1+g^Y)^h \sum_{s=0}^{h} \delta g_{t+s}^Y$$

The above assumes that the baseline growth rate, i.e. without the effect of the shock, is constant: $g_{t+i}^Y = g^Y$, for all i. Also, using definitions, we have: $\delta G_t = gss_t G_{t-1}$.

Introducing into the previous and summing up over H-1 (so that the horizon is H quarters) we obtain:

$$\sum_{h=0}^{H-1} (\frac{\delta Y_{t+h}}{\delta G_t})(1+r)^{-h} = \frac{Y_{t-1}}{G_{t-1}} \sum_{h=0}^{H-1} \frac{(1+g^Y)^h}{(1+r)^h} \sum_{s=0}^{h} \frac{\delta g_{t+s}^Y}{gss_t} \approx \frac{Y_{t-1}}{G_{t-1}} \sum_{h=0}^{H-1} \sum_{s=0}^{h} \frac{\delta g_{t+s}^Y}{gss_t} = \frac{Y_{t-1}}{G_{t-1}} \sum_{h=0}^{H} (H-h) \frac{\delta g_{t+h}^Y}{gss_t} \tag{4.4}$$

The approximation follows from assuming $g_t^Y \approx r$; with quarterly data and H=4 or 8, the error will be negligible. Note also that, in order to move away from percentage effects (implicit in growth rates) and obtain 'dollar effects', we multiply $\frac{Y_{t-1}}{G_{t-1}}$ and not by sample means; thus, we avoid a pitfall highlighted by Ramey (2019) that could bias our results.

Finally, using equation (4.4) and replacing $\frac{\delta g_{t+i}^Y}{gss_t}$ by the regression coefficients in equation (6), we have:

$$m_t = \sum_{h=0}^{H-1} (\frac{\delta Y_{t+h}}{\delta G_t})(1+r)^{-h} = \frac{Y_{t-1}}{G_{t-1}} \sum_{h=0}^{H-1} (H-h) \left[F(z_{t-1})(\beta_{R,h}^{Y+} + \beta_{R,h}^{Y-}) + (1 - F(z_{t-1})(\beta_{E,h}^{Y+} + \beta_{E,h}^{Y-}) \right] \tag{4.5}$$

Following from the differentiation of shocks, these PVIR-type of multipliers are also differentiated as $m_t = m_t^{ALL}$, m_t^+, m_t^-, corresponding to the three cases of $\beta_{i,h}^{Y+} = \beta_{i,h}^{Y-}$, $\beta_{i,h}^{Y-} = 0$ and $\beta_{i,h}^{Y+} = 0$, respectively. The results are presented accordingly. It is worth noting that all versions of m_t are complete series, even though the positive/negative shocks series are not complete, as these PVIR-FMs are built on the estimated coefficients from the instances when the shocks do exist.

4.3.1.2 Financial Efficacy Coefficient - Fiscal Multiplier (FEC-FM)

As mentioned, in the spirit of Mountford and Uhlig (2009) and Ramey (2019), we present the coefficient that shows the output effect of a given spending shock compared to all the government spending that it elicits.

$$M_t \equiv \sum_{h=0}^{H-1} (\frac{\delta Y_{t+h}}{\delta G_t})(1+r)^{-h} - \sum_{h=0}^{H-1} (\frac{\delta G_{t+h}}{\delta G_t})(1+r)^{-h}$$

Again, this is the difference (in \$) between the sum of output effects (the present value of deviations from the baseline), minus the sum of such effects on future spending, arising out of a \$1 unexpected increases in spending at time t. The first part of the ratio is simply m_t; to get the latter, we expand in a familiar way:

$$\sum_{h=0}^{H-1}(\frac{\delta G_{t+h}}{\delta G_t})(1+r)^{-h} = \frac{G_{t-1}}{G_{t-1}}\sum_{h=0}^{H-1}\frac{(1+g^G)^h}{(1+r)^h}\sum_{s=0}^{h}\frac{\delta g^G_{t+s}}{gss_t} \approx \sum_{h=0}^{H-1}\sum_{s=0}^{h}\frac{\delta g^G_{t+s}}{gss_t} = \sum_{h=0}^{H-1}(H-h)\frac{\delta g^G_{t+h}}{gss_t}$$

To get that, we estimate the above with the growth rate of government spending g^G_{t+h} as the dependent variable:

$$\begin{aligned} g^G_{t+h} = F(z_{t-1})(\alpha^G_{R,h} + \psi^G_{R,h}(L)X_{t-1} + \beta^{G+}_{R,h}FE^+_{t|t-1} + \beta^{G-}_{R,h}FE^-_{t|t-1}) + \\ + (1-F(z_{t-1}))(\alpha^G_{E,h} + \psi^G_{E,h}(L)X_{t-1} + \beta^{G+}_{E,h}FE^+_{t|t-1} + \beta^{G-}_{E,h}FE^-_{t|t-1}) + \varepsilon_{t+h}\ , \end{aligned} \tag{4.6}$$

This is in complete analogy to eq. (4.5) above. Therefore, assuming that the trend growth of output and government spending are both equal to the real interest rate, $g^Y = g^G \equiv r$, the EC-FM becomes:

$$M_t = m_t - \sum_{h=0}^{H-1}(H-h)\frac{\delta g^G_{t+h}}{gss_t} = m_t - \sum_{h=0}^{H-1}(H-h)\left[F(z_{t-1})(\beta^{G+}_{R,h}+\beta^{G-}_{R,h}) + (1-F(z_{t-1})(\beta^{G+}_{E,h}+\beta^{G-}_{E,h})\right] \tag{4.7}$$

Again, we show $M_t = M_t^{ALL}$, M_t^+, M_t^-, corresponding to the three cases of $\beta^{G+}_{i,h} = \beta^{G-}_{i,h}$, $\beta^{G-}_{i,h} = 0$ and $\beta^{G+}_{i,h} = 0$, respectively, for $i = R, E$.

4.4 Empirical Results

We first report key statistics related to the PVIR-FMs, over two horizons (H=4,8 quarters), using the original shocks; see Table 4.1a. A reminder that these give the present value of output effects (in \$) arising from an unanticipated government spending shock equal to \$1. The present-value effect of an individual shock is below unity for four quarters (H=4), but it exceeds that by a big margin in the case of eight quarters. This is so for all types of shock, whether pooled (all), positive or negative. Thus, one first result is that it takes a few quarters for the full effect of government spending to be felt on output. Regarding the differential between positive and negative shocks, the key question we ask in this chapter, we find that in the four-quarter horizon, the negative shocks have a larger impact; but this is reversed in the eight-quarter horizon, when positive shocks have a greater impact. Thus, the effect of the negative shocks is sharper in shorter horizons. The persistence of the effects of fiscal consolidations has been pointed out by Fatás and Summers (2018); here, we show that the effects of both fiscal expansions and consolidations are persistent.

A further result concerns the strong counter-cyclicality of these impulse response multipliers, as can be seen in Figures (4.1a,b); their correlation coefficient with Hodrick-Prescott-filtered output (y_t) is around -0.25. This result will be seen to be robust below. In other words, the multipliers are high during recessions and low during expansions. This finding, noted in previous literature, is confirmation of the basic macroeconomics discussed above; namely that fiscal shocks have a greater effect when there is slackness in the economy. Furthermore, in the H=4 case, the PVIR-FM of the contractionary shocks has a greater variance than that of the positive shocks. This enhances the stronger effect of the negative shocks during recessions. In general, while the estimates are low much of the time, they rise sharply during recessions; in the four-quarter horizon, to about 2 around 1991 and 2001 and to as much as 6 during 2007-9; the corresponding figures in the eight-quarter horizon case are 10 and 25. The result is that the effectiveness of government spending as a stabilisation tool rises sharply when it is most needed, i.e. during recessions.

Fourthly, and continuing, shocks of all signs occasionally have an impact with a negative sign; such effects occur about 20% of the time, always during expansions. Primarily, this is the case with negative shocks, which during such episodes have an expansionary effect; we find here evidence of 'expansionary fiscal contractions' suggested by a strand in earlier literature. This effect arises, the argument goes, as a current consolidation generates expectations of a better shape concerning public finances, thus less future taxation and more future growth, which has a feedback on current growth. The issue remains hotly debated and some of these findings have been critical revisited (see Hernandez de Cos and Moral-Benito, 2013, and Perotti, 2013, for critical discussion and references to the earlier literature). One contribution of this chapter is to offer a reconciliation between the conflicting results: While a fiscal consolidation (austerity) normally has contractionary effects, during booms, it may on occasion produce expansionary effects. In Figues 4.1a (i, ii), we show graphically the PVIR-FMs presented in Table 1a in summary form.

Table 4.1a: Summary Statistics of the PVIR-FMs; Original Shocks (gss_t)

		All shocks (m_t^{ALL})	Positive shocks (m_t^{+})	Negative shocks (m_t^{-})
H=4	Average	0.93	0.77	0.84
H=4	St.dev.	1.67	1.38	1.83
H=4	Corr(m_t,y_t)	-0.27	-0.27	-0.27
H=4	Max	7.11	5.82	7.61
H=4	Min	-1.34	-1.11	-1.66
H=8	Average	4.97	4.98	4.72
H=8	St.dev.	6.08	6.34	5.07
H=8	Corr(m_t,y_t)	-0.27	-0.27	-0.26
H=8	Max	27.34	28.30	23.33
H=8	Min	-3.23	-3.58	-2.08

Notes: m_t^{ALL}, m_t^{+} and m_t^{-} are the present value impulse response fiscal multipliers for (i) all, (ii) positive and (iii) negative shocks respectively.

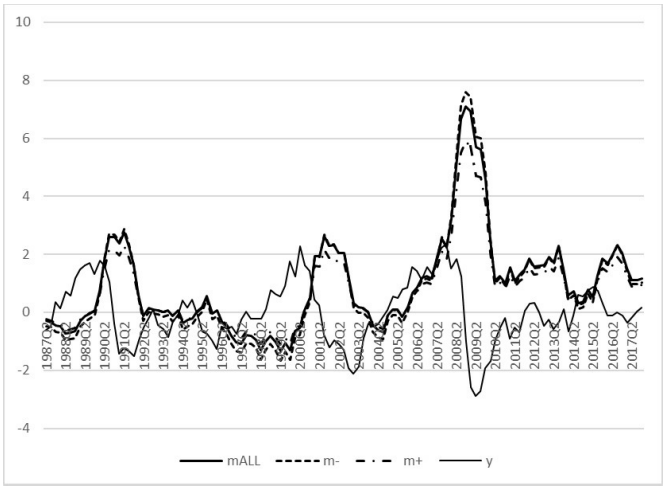


Figure 4.1a(i): Plots of the PVIR-FMs, Original Shocks - All (mALL), Negative (m-) and Positive (m+), y is the Detrended Output (H=4)

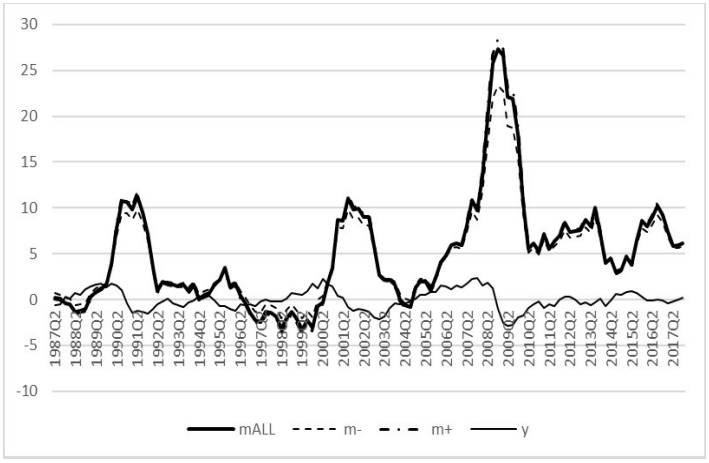


Figure 4.1a(ii): Plots of the PVIR-FMs, Original Shocks - All (mALL), Negative (m-) and Positive (m+), y is the Detrended Output (H=8)

Table 4.1b: Summary Statistics of the FEC-FMs, Original Shocks (gss_t)

		All shocks (M_t^{ALL})	Positive shocks (M_t^{+})	Negative shocks (M_t^{-})
H=4	Average	0.03	−0.01	0.07
H=4	St.dev.	0.05	0.05	0.08
H=4	Corr(M_t,y_t)	0.29	0.29	−0.30
H=4	Max	0.10	0.06	0.37
H=4	Min	−0.16	−0.21	−0.03
H=8	Average	0.05	0.01	0.11
H=8	St.dev.	0.13	0.13	0.01
H=8	Corr(M_t,y_t)	0.29	0.29	0.16
H=8	Max	0.21	0.18	0.11
H=8	Min	−0.41	−0.44	0.08

Notes: M_t^{ALL}, M_t^{+} and M_t^{-} are the effectiveness coefficient fiscal multipliers for (i) all, (ii) positive and (iii) negative shocks respectively.

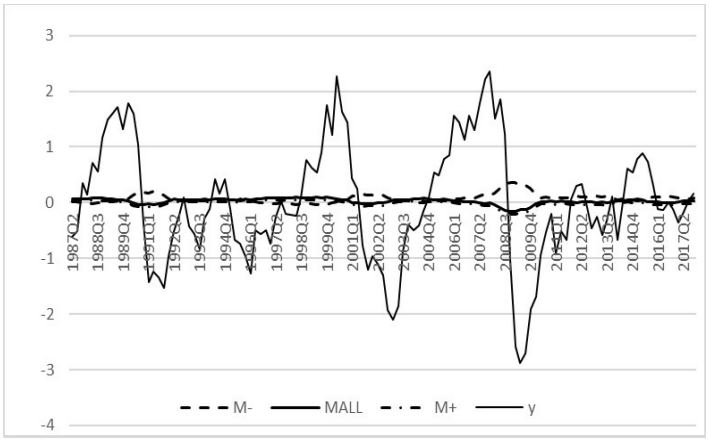


Figure 4.1b(i): Plot of the FEC-FMs, Original Shocks - All (MALL), Negative (M-) and Positive (M+), y is the Detrended Output (H=4)

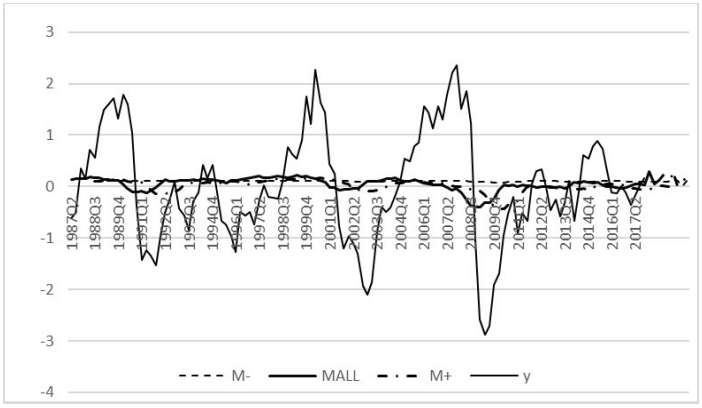


Figure 4.1b(ii): Plot of the FEC-FMs, Original Shocks - All (MALL), Negative (M-) and Positive (M+), y is the Detrended Output (H=8)

Table 4.1b summarise the FEC-FM arising out of the original shock. Several results become apparent. Firstly, again there is a difference between the estimates for four- and eight-quarter horizons. When H=4, the difference between negative and positive shocks is quite sharp. On average, $M_t^+ = -0.01$, while $M_t^- = 0.07$. Furthermore, the procyclicality of M_t^+ implies that, during recessions, the output effect of the fiscal shock rises but less so than the effect on spending; hence M_t^+ falls. But M_t^- rises during recessions - to about 0.75 around 1991 and 2001 and more than 1.5 around 2008. The conclusion from these estimates is that not only are the effects of the positive and negative shocks different; their state-dependence also differs sharply. As a corollary, negative shocks during recessions are quite damaging to output. In the case of a longer horizon (H=8), the same difference in magnitude is evident between the FEC-FMs of positive and negative shocks (0.1 and 0.11, respectively). Here our results echo Fatás and Summers (2018) in finding the persistent effects of fiscal consolidations. However, both M_t^+ and M_t^- are procyclical, in contrast to the H=4 case. With respect to negative shocks, in particular, these multipliers suggest that a \$1 fall in fiscal spending crowds out \$0.11 of private spending (over 8 quarters,

as a present value); while the corresponding figure is \$0.07 in the H=4 case. We return below to the question of whether the difference between positive and negative shocks is statistically significant; see Table 4 and surrounding discussion. Figues 4.1b (i, ii) show graphically these FEC-FMs.

As a robustness check, we return to the specification of the fiscal (spending) shocks. As pointed out by Ramey (2019), it is possible that the forecast error as presented in statistics may not be white noise; by potentially being correlated with other variables, it may not represent a genuinely independent innovation in fiscal policy. To investigate this, we show estimates based on the same model and estimation method, but different shocks. Our first variant is based on shock produced by filtering out any correlation of $FE^{ALL}_{t|t-1}$ with detrended output (y_t); in other words, the shock is the error term (e_t) from the regression:

$$FE^{ALL}_{t|t-1} = \alpha + \gamma y_t + e^{ALL}_{t|t-1}$$

We then let the shock be: $gss'_t = e^{ALL}_{t|t-1}$, $e^{-}_{t|t-1}$, $e^{+}_{t|t-1}$, i.e. by filtering out positive or negative values, in complete analogy as before. The interpretation of the resulting PVIR-FMs (shown in Table 4.2a) and FEC-FMs (Table 4.2b) is the same. The corresponding Figures are 4.2a (i, ii) and 4.2b (i, ii). Regarding PVIR-FMs, the results are similar to those in Table 4.1a, in that the effect of negative shocks is higher than that of the positive shocks in the H=4 case (but slightly lower than the all-shocks case); in fact, all values are somewhat higher than in Table 1a. In the H=8 case, again the effect of positive shocks is somewhat higher (as in Table 4.1a). In addition, all PVIR-FMs are countercyclical, with the same correlation coefficient (of the order of -0.27). The FEC-FM of Table 4.2b also shows a greater multiplier for the negative shocks in the short horizon (H=4) but only marginally so in the longer horizon (H=8). In other words, all shocks have persistent effects. A notable difference with the results of Table 4.1b is that now these multipliers are countercyclical in all cases - both horizons and all types of shock.

Table 4.2a: Summary Statistics of the PVIR-FMs, Shocks Uncorrelated with Output (gss'_t)

		All shocks (m_t^{ALL})	Positive shocks (m_t^{+})	Negative shocks (m_t^{-})
H=4	Average	1.04	0.84	1.00
H=4	St.dev.	1.73	1.43	1.83
H=4	Corr(m_t,y_t)	−0.27	−0.27	−0.27
H=4	Max	7.43	6.13	7.76
H=4	Min	−1.30	−1.11	−1.50
H=8	Average	4.98	5.03	4.47
H=8	St.dev.	6.19	5.97	4.86
H=8	Corr(m_t,y_t)	−0.27	−0.27	−0.26
H=8	Max	27.75	27.00	22.31
H=8	Min	−3.37	−3.01	−2.05

Notes: m_t^{ALL}, m_t^{+} and m_t^{-} are the present value impulse response fiscal multipliers for (i) all, (ii) positive and (iii) negative shocks respectively.

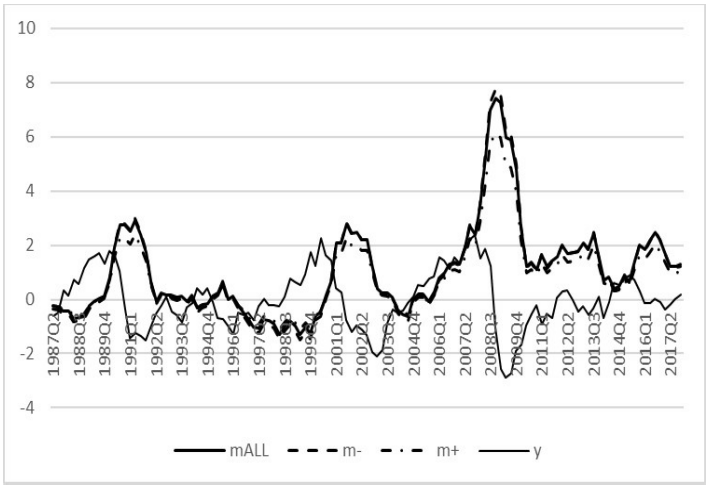


Figure 2a(i): Plots of PVIR-FMs, Shocks Uncorrelated with Output (gss_t') - All Shocks (mALL), Negative (m-) and Positive (m+), y is the Detrended Output (H=4)

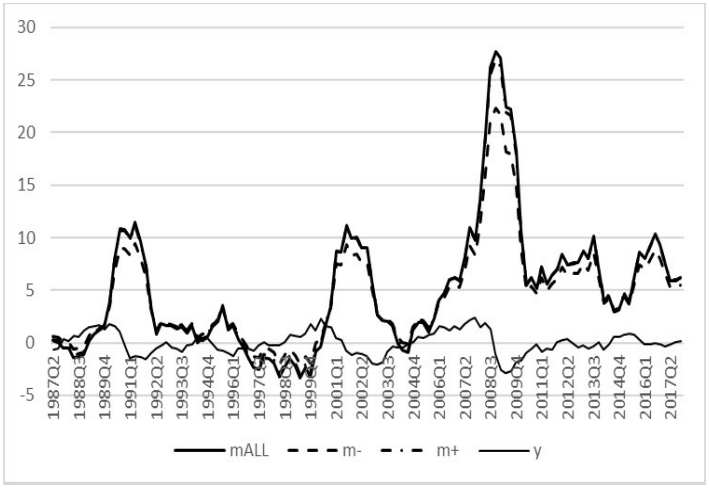


Figure 4.2a(ii): Plots of PVIR-FMs, Shocks Uncorrelated with Output (gss_t') - All Shocks (mALL), Negative (m-) and Positive (m+), y is the Detrended Output (H=8)

Table 4.2b: Summary Statistics of the FEC-FMs, Shocks Uncorrelated with Output (gss_t')

		All shocks (M_t^{ALL})	Positive shocks (M_t^{+})	Negative shocks (M_t^{-})
H=4	Average	0.28	0.19	0.31
H=4	St.dev.	0.38	0.31	0.53
H=4	Corr(M_t,y_t)	−0.27	−0.27	−0.27
H=4	Max	1.68	1.34	2.27
H=4	Min	−0.24	−0.23	−0.41
H=8	Average	0.64	0.62	0.64
H=8	St.dev.	0.63	0.61	0.59
H=8	Corr(M_t,y_t)	−0.26	−0.26	−0.26
H=8	Max	2.98	2.86	2.83
H=8	Min	−0.21	−0.20	−0.16

Notes: M_t^{ALL}, M_t^{+} and M_t^{-} are the effectiveness coefficient fiscal multipliers for (i) all, (ii) positive and (iii) negative shocks respectively.

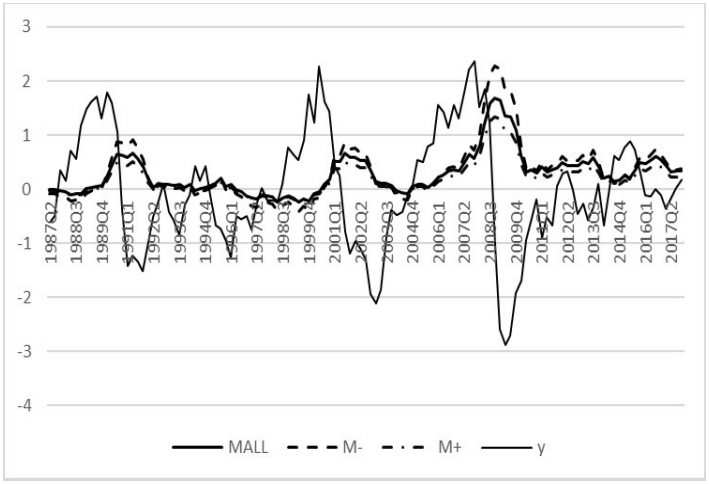


Figure 4.2b(i): Plots of FEC-FMs, Shocks Uncorelated with the Output (gss_t') - All Shocks (MALL), Negative (M-) and Positive (M+), y is the Detrended Output (H=4)

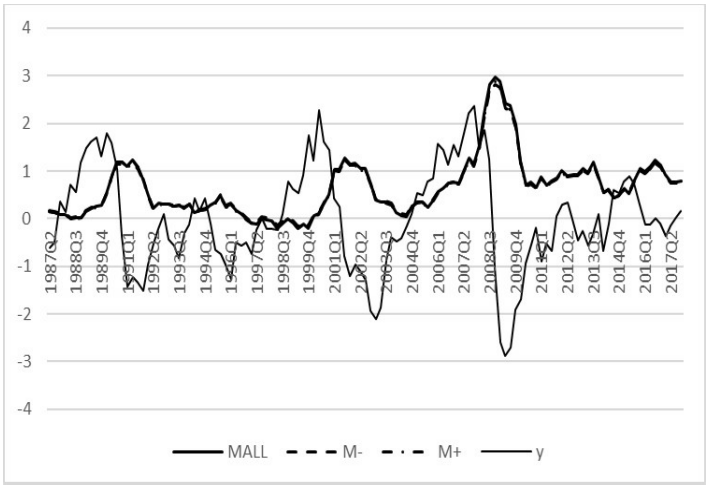


Figure 4.2b(ii): Plots of FEC-FMs, Shocks Uncorelated with the Output (gss_t') - All Shocks (MALL), Negative (M-) and Positive (M+), y is the Detrended Output (H=8)

A second variant of the shock specification postulates an AR(1) structure for the forecast error $FE^{ALL}_{t|t-1}$ and filters out any predictable component accordingly; in other words, the shock is the error term (v_t) from the regression:

$$FE^{ALL}_{t|t-1} = \alpha + \beta FE^{ALL}_{t-1|t-2} + v^{ALL}_{t|t-1}$$

We then let the shock be: $gss_t^{''} = v^{ALL}_{t|t-1}$, $v^{-}_{t|t-1}$, $v^{+}_{t|t-1}$, again filtering out positive or negative values as before. The PVIR-FM and FEC-FM (Tables 4.3a and 4.3b, respectively) are interpreted in the same way. The key results of Table 4.3a are the same, except that all effects are now higher. In particular, the effect of PVIR-FM in H=4 is now clearly higher than unity for all shocks; and the effects of H=8 are correspondingly higher. Otherwise, we make similar observations: Negative shocks produce higher PVIR-FMs under H=4; and all effects are counter-cyclical. The FEC-FM in Table 4.3b also shows a greater multiplier for the short horizon (H=4) but a smaller one for the longer horizon (H=8). Similar points about persistence can be made as in the context of previous Tables. In common with Table 4.2b and in contrast to the results of Table 4.1b, these multipliers are countercyclical in all cases - both horizons and all types of shock. The corresponding graphs are given in Figures 4.3a (i, ii) and 4.3b (i, ii).

Table 4.3a: Summary Statistics of the PVIR-FMs, Shocks as Residuals from an AR1 Process of the Original Shocks (gss_t'')

		All shocks (m_t^{ALL})	Positive shocks (m_t^{+})	Negative shocks (m_t^{-})
H=4	Average	1.06	1.18	1.32
H=4	St.dev.	1.69	1.89	2.71
H=4	Corr(m_t,y_t)	−0.27	−0.27	−0.2
H=4	Max	7.30	8.17	11.31
H=4	Min	−1.24	−1.39	−2.38
H=8	Average	5.41	8.50	6.14
H=8	St.dev.	6.30	10.65	5.92
H=8	Corr(m_t,y_t)	−0.26	−0.27	−0.26
H=8	Max	28.57	47.71	27.85
H=8	Min	−3.06	−5.87	−1.77

Notes: m_t^{ALL}, m_t^{+} and m_t^{-} are the present value impulse response fiscal multipliers for (i) all, (ii) positive and (iii) negative shocks respectively.

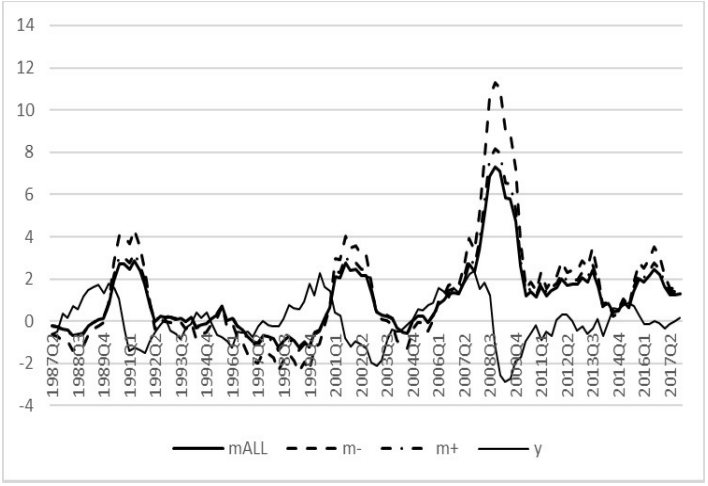


Figure 4.3a(i): Plots of PVIR-FMs, Shocks as Residuals from an AR1 Process of the Original Shocks (gss_t'') - All (mALL), Negative (m-) and Positive (m+), y is the Detrended Output (H=4)

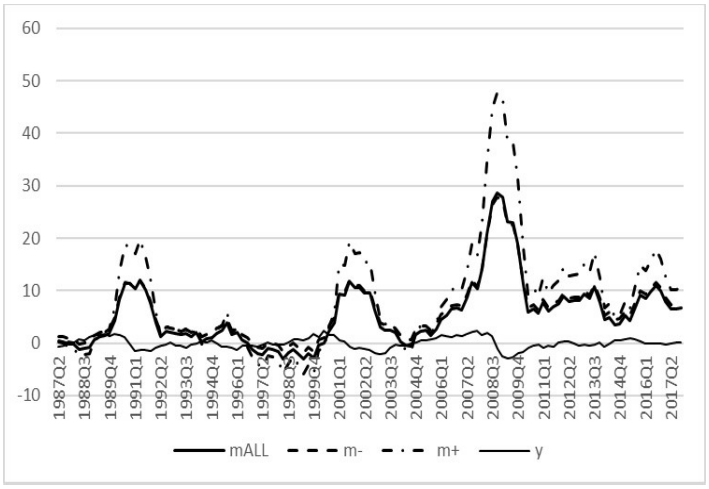


Figure 4.3a(ii): Plots of PVIR-FMs, Shocks as Residuals from an AR1 Process of the Original Shocks ($gss_t^{''}$) - All (mALL), Negative (m-) and Positive (m+), y is the Detrended Output (H=8)

Table 4.3b: Summary Statistics of the EC-FM, Shocks as Residuals from an AR1 Process of the Original Shocks ($gss_t^{''}$)

		All shocks (M_t^{ALL})	Positive shocks (M_t^{+})	Negative shocks (M_t^{-})
H=4	Average	0.24	0.23	0.33
H=4	St.dev.	0.37	0.37	0.63
H=4	Corr(M_t,y_t)	−0.27	−0.27	−0.27
H=4	Max	1.62	1.60	2.67
H=4	Min	−0.26	−0.27	−0.53
H=8	Average	0.66	0.95	0.77
H=8	St.dev.	0.62	1.06	0.49
H=8	Corr(M_t,y_t)	−0.26	−0.26	−0.24
H=8	Max	2.97	4.86	2.59
H=8	Min	−0.19	−0.48	0.12

Notes: M_t^{ALL}, M_t^{+} and M_t^{-} are the effectiveness coefficient fiscal multipliers for (i) all, (ii) positive and (iii) negative shocks respectively.

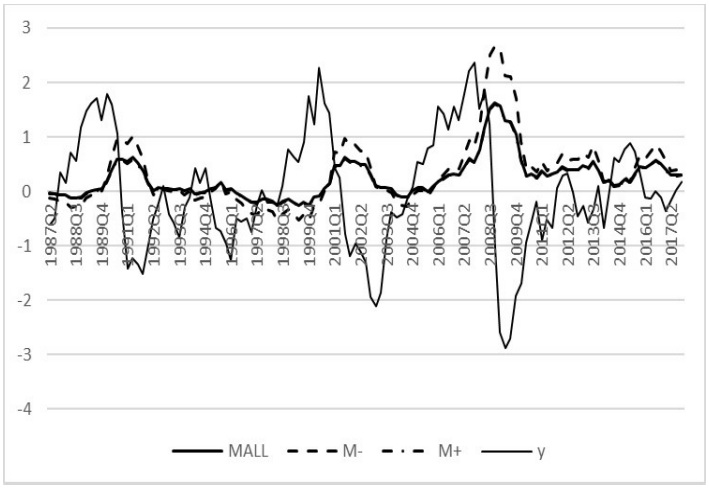


Figure 4.3b(i): Plots of FEC-FMs, Shocks as Residuals from an AR1 Process of the Original Shocks ($gss_t^{''}$) - All (MALL), Negative (M-) and Positive (M+), y is the Detrended Output (H=4)

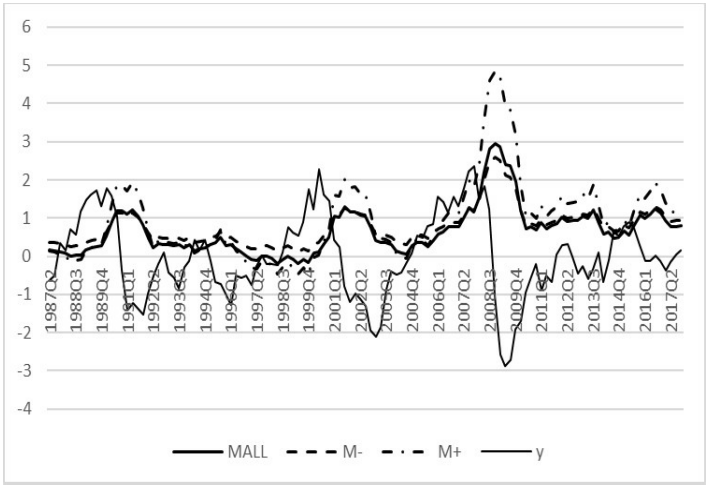


Figure 4.3b(ii): Plots of FEC-FMs, Shocks as Residuals from an AR1 Process of the Original Shocks ($gss_t^{''}$) - All (MALL), Negative (M-) and Positive (M+), y is the Detrended Output (H=8)

How Significant is the Difference in the Effects of the Expansionary and Contractionary Shocks?

We now investigate the significance of the difference in the effects of the two types of shock. A reminder that our key hypothesis is that the numerical effect (except the sign) of the contractionary shocks is higher on average than that of the expansionary shocks.

A significance test can be done at two levels, firstly testing for the significance of the difference between the key estimated coefficients of equation:

$$g^Y_{t+h} = F(z_t)(\alpha^Y_{R,h} + \psi^Y_{R,h}(L)X_{t-1} + \beta^{Y+}_{R,h}FE^+_{t|t-1} + \beta^{Y-}_{R,h}FE^-_{t|t-1}) + \tag{4.8}$$
$$+ (1 - F(z_t))(\alpha^Y_{E,h} + \psi^Y_{E,h}(L)X_{t-1} + \beta^{Y+}_{E,h}FE^+_{t|t-1} + \beta^{Y-}_{E,h}FE^-_{t|t-1}) + \varepsilon_{t+h} \ ,$$

And secondly, one could test the significance of the difference in the multipliers reported in Tables 4.1-4.3. While the multipliers provide the economically relevant information, they do also rely on the sample, econometric methodology, horizon, and particular assumptions (e.g. about the interest rate), see Ramey (2019). On the other hand, the estimated coefficients are not readily interpretable in an economic manner, but a difference between them will be an indication that expansionary and contractionary shocks work differently. We therefore proceed by investigating the differences in both respects. In all tests, we assume that the timing of positive versus positive shocks is random.[43]

The key parameters of interest are the pairs $\beta^{Y+}_{R,h}$, $\beta^{Y-}_{R,h}$ and $\beta^{Y+}_{E,h}$, $\beta^{Y-}_{E,h}$ for each $h = 0, 1, 2, ...7$. A test of equality of two estimated parameters is based on the statistic $T = \frac{\sqrt{n_1 n_2}(\beta_1 - \beta_2)}{\sqrt{n_1 S_1^2 + n_2 S_2^2}}$, where n_1, n_2 are the sample sizes, β_1, β_2 the estimated parameters and S_1^2, S_2^2 their standard errors (see Mood, Graybill and Boes, 1974, p. 435). In our case, samples 1 and 2 represent the negative and positive shocks, respectively, for every pair of parameters of interest. For instance, $\beta_1 = \beta^{Y-}_{R,h}$ and $\beta_2 = \beta^{Y+}_{R,h}$; so, a test must be performed for both recessions (R) and expansions (E) and for each h (see Table 4.4 below). We perform the tests for the estimates based on the original shocks (gss_t), the shocks uncorrelated with output (gss'_t), and the shocks as residuals from an AR1 process of the original shocks (gss''_t). With a sample size of 126, the sample sizes are $n_1 = 67$, and $n_2 = 59$, fixed in all cases. All statistics follow the t-distribution with $n_1 + n_2$ degrees of freedom. As we allow for either possibility, the test is two-sided; the critical values at the 1%, 5% and 10% levels of significance are, respectively, 2.62, 1.98 and 1.66; they are indicated by ***, ** and *. Table 4.4 below reports the statistics. In order not to clatter the exposition, we refrain from showing the raw estimates and their sample variances (which are available on request) and show only the corresponding T-statistic.

Table 4.4: Test of Equality of Estimated Coefficients (T-statistic); See the Text for Details.

	Model/statistic					
Model	Original shocks (gss_t)		Shocks uncorrelated with output (gss'_t)		Shocks from AR1 (gss''_t)	
	statistic related to		statistic related to		statistic related to	
horizon	$\beta^{Y-}_{R,h} - \beta^{Y+}_{R,h}$	$\beta^{Y-}_{E,h} - \beta^{Y+}_{E,h}$	$\beta^{Y-}_{R,h} - \beta^{Y+}_{R,h}$	$\beta^{Y-}_{E,h} - \beta^{Y+}_{E,h}$	$\beta^{Y-}_{R,h} - \beta^{Y+}_{R,h}$	$\beta^{Y-}_{E,h} - \beta^{Y+}_{E,h}$
h=0	4.68***	−3.13***	−2.68***	6.49***	−13.35***	12.23***
h=1	−4.96***	2.53**	3.75***	−2.57**	38.13***	−26.56***
h=2	−5.82***	11.83***	9.61***	−13.78***	−14.18***	11.98***
h=3	3.08***	−3.32***	−4.32***	−0.62	6.68***	−4.27***
h=4	−2.52**	3.07***	4.31***	2.56***	−12.07***	12.74***
h=5	−20.48***	18.79***	6.65***	3.36***	−17.24***	28.21***
h=6	−10.70***	4.55***	14.00***	−17.48***	−3.72***	0.51
h=7	1.17	−1.94*	−9.11***	7.41***	−7.36***	11.91***

As shown in the Table, the difference in the estimated coefficients of the regressions run separately for the contractionary and expansionary shocks is significant almost everywhere - in the overwhelming majority of cases at the 1% singificance level. These results confirm that the two types of shock have significantly different effects, manifested in different estimated coefficients of the main estimable equation.

[43] Hernandez de Cos and Moral-Benito (2013) points out that the timing of fiscal consolidations is not exogenous (as often assumed); consolidations are more likely to go ahead when times are good, and they are likely to stop (even temporarily) when there is a recession. Accounting for this endogeneity and reverse causality is at the heart of their critique of 'expansionary fiscal consolidations'. But a key inference for our purposes is that, if anything, the difference between positive and negative shocks is understated; as fiscal expansions occur in recessions, when they have their highest effects, while contractions occur in good times, when their effects are probably more muted.

Clearly, the regressions that predict the effects of the negative and positive shocks are significantly different in terms of parameters (though of the same structure).

Furthermore, in order to see how these differences translate into economic effects, we next report in Table 4.5 the significance of the differences in the pairs of multipliers. In view of equation (4.5), the differences are given by:

$$m_t^- - m_t^+ = \sum_{h=0}^{H-1}(\frac{\delta Y_{t+h}}{\delta G_t})(1+r)^{-h} = \frac{Y_{t-1}}{G_{t-1}}\sum_{h=0}^{H-1}(H-h)\left[F(z_{t-1})(\beta_{R,h}^{Y-} - \beta_{R,h}^{Y+}) + (1-F(z_{t-1})(\beta_{E,h}^{Y-} - \beta_{E,h}^{Y+})\right] \tag{4.9}$$

To test for significance, we first construct t-statistics of the PVIR-FM multipliers ($t(m_t^- - m_t^+)$) as follows:

$$t(m_t^- - m_t^+) = \frac{m_t^- - m_t^+}{\sqrt{Var(m_t^- - m_t^+)}} \tag{4.10}$$

using the variance:

$$Var(m_t^- - m_t^+) = \left(\frac{Y_{t-1}}{G_{t-1}}\right)^2 \sum_{h=0}^{H-1}(H-h)^2 \left[\begin{array}{cc} F(z_{t-1}) & (1-F(z_{t-1}) \end{array}\right] x \tag{4.10}$$
$$x \left\{VCOV(\boldsymbol{\beta}_{R,h}^{Y-}, \boldsymbol{\beta}_{E,h}^{Y-}) + VCOV(\boldsymbol{\beta}_{R,h}^{Y+}, \boldsymbol{\beta}_{E,h}^{Y+})\right\} \left[\begin{array}{c} F(z_{t-1}) \\ (1-F(z_{t-1}) \end{array}\right]$$

This follows from the construction of the difference in the multipliers in eq. (4.9), noting that $VCOV(\boldsymbol{\beta}_{R,h}^{Y-}, \boldsymbol{\beta}_{E,h}^{Y-})$ is the 2x2 variance-covariance matrix of the coefficients in recession and expansion, and noting that there is no covariance between $\boldsymbol{\beta}_{R,h}^{Y+}, \boldsymbol{\beta}_{R,h}^{Y-}$ nor between $\boldsymbol{\beta}_{E,h}^{Y+}, \boldsymbol{\beta}_{E,h}^{Y-}$ as these coefficients in these pairs have been estimated in separate regressions for expansionary and contractionary shocks. The variance is time-varying because both $\frac{Y_{t-1}}{G_{t-1}}$and $F(z_{t-1})$ are time-varying; and the t-statistics will be, too, because of both numerator and denominator. Hence, we do not provide sample averages, but we report in Table 4.5 the percentage of time in our sample when the relevant t-statistic is significant. Significance will be jusdged against the usual critical value of ± 1.96. We report these results in Table for the PVIR-FM ($m_t^- - m_t^+$) for each of $H = 4, 8$ and each of the three constructions of the fiscal shock (original, detrended, and cleaned of autocorrelation) - six sets in all. More detail in relation to Table 4.5 will follow shortly.

The latter set of columns of Table 4.5 report the t-statistics related to the FEC-FM multipliers ($M_t^- - M_t^+$). The steps required in order to construct this set of t-statistics follow the above lines and the definition, see eq. (4.7): Therefore, we have:

$$Var(M_t^- - M_t^+) = Var(m_t^- - m_t^+) + Var(B_t^- - B_t^+) - 2Cov\left\{ \; m_t^- - m_t^+, \quad (B_t^- - B_t^+) \; \right\} \tag{4.10}$$

where the latter part is essentially the multipliers relating to government spending itself:

$$B_t^- - B_t^+ \equiv \sum_{h=0}^{H-1}(H-h)\left[F(z_{t-1})(\beta_{R,h}^{G-} - \beta_{R,h}^{G+}) + (1-F(z_{t-1})(\beta_{E,h}^{G-} - \beta_{E,h}^{G+})\right] \tag{4.11}$$

Therefore in exact analogy with eq. (11) above, we get:

$$Var\left\{B_t^- - B_t^+\right\} = \sum_{h=0}^{H-1}(H-h)^2 \left[\begin{array}{cc} F(z_{t-1}) & (1-F(z_{t-1}) \end{array}\right] x \tag{4.12}$$
$$x \left\{VCOV(\boldsymbol{\beta}_{R,h}^{G-}, \boldsymbol{\beta}_{E,h}^{G-}) + VCOV(\boldsymbol{\beta}_{R,h}^{G+}, \boldsymbol{\beta}_{E,h}^{G+})\right\} \left[\begin{array}{c} F(z_{t-1}) \\ (1-F(z_{t-1}) \end{array}\right]$$

For simplicity, calculation of $Cov\left\{ \ m_t^- - m_t^+, \quad B_t^- - B_t^+ \ \right\}$ was done using the formula:

$Cov\left\{ \ m_t^- - m_t^+, \quad B_t^- - B_t^+ \ \right\} = r\sqrt{Var(m_t^- - m_t^+)}\sqrt{Var(B_t^- - B_t^+)}$, where r is the correlation coefficient between $m_t^- - m_t^+, \quad B_t^- - B_t^+$. Finally, in analogy with eq. (10), we construct:

$$t(M_t^- - M_t^+) = \frac{M_t^- - M_t^+}{\sqrt{Var(M_t^- - M_t^+)}}, \tag{4.13}$$

to be compared with the critical values of ± 1.96. These steps were again followed for each $H = 4, 8$ and each of the three constructions of the fiscal shock.

To recap, for each multiplier, horizon (H=4 or H=8), and method of construction of the shock, Table 4.5 shows (a) the average of $m_t^- - m_t^+$ or $M_t^- - M_t^+$ over the sample, (b) the percentage of the sample when this difference is significant and (c) the correlation with Hodrick-Prescott-filtered output. The focus of attention is the middle element in each group of three - the percentage of time when the difference is significant; but the average (also discernible from the Tables above) and the correlation with the output growth rate also provide valuable information.

Table 4.5: Significance of Differences of Multipliers; See the Text for Details.

Model/Horizon		statistic related to PVIR-FM: $m_t^- - m_t^+$		statistic related to FEC-FM: $M_t^- - M_t^+$	
		$H = 4$	$H = 8$	$H = 4$	$H = 8$
Original shocks (T. 4.1a, b)	Average	0.07	−0.26	0.08	0.10
	% of sample significant	**99**%	**96**%	0%	15%
	corr. with HP-output	−0.29	0.24	−0.18	0.04
Uncorrelated shocks (T. 4.2a, b)	Average	0.16	−0.56	0.12	0.02
	% of sample significant	**93**%	**80**%	0%	0%
	corr. with HP-output	−0.31	0.14	−0.21	0.21
Residuals from AR1 (T. 4.3a, b)	Average	0.14	−2.35	0.10	−0.18
	% of sample significant	**93**%	**94**%	0%	33%
	corr. with HP-output	−0.07	0.28	−0.26	0.04

Notes: m_t^- and m_t^+ are the present value impulse response fiscal multipliers (PVIR-FM) for negative and positive shocks respectively. M_t^- and M_t^+ are the counterpart effectiveness coefficient fiscal multipliers (FEC-FM).

The results are illuminating, if somewhat mixed. Crucially for our purposes here, the differences in the PVIR multipliers (left part of the Table) are strongly significant - being significant upwards of 80% of the time in our sample (highlighted entries in the Table). Looking at finer detail, the difference at horizon H=4 has always the expected sign (positive: the contractionary shock has a stronger effect). The difference is mildly counter-cyclical. Differences in the multipliers at the longer horizon (H=8) are negative: The expansionary shocks have a stronger effect. This suggests that negative shocks have a stronger immediate impact, as also pointed out above. In contrast, the effect of the positive shocks takes a longer horizon to materialise, hence the difference is negative at H=8. Such a conclusion would be in line with theory-based intuition as outlined in the Introduction, as positive shocks involve more capacity-building that requires time. Additionally, these differences are mildly pro-cyclical. But this diversity across horizons should not overshadow the key finding that the difference in multipliers between contractionary and expansionary shocks is highly significant.

The differences in the FEC multipliers, on the other hand (latter set of columns), are on the whole rather insignificant, showing a significance in limited time periods in a couple of instances. In terms of signs and cyclicality, the differences in FEC-FMs are similar on the whole to the differences in PVIR-FMs. One conjecture for the lack of significance is that, although all shocks show persistent effects as remarked above, the relative persistence varies between the effects on output and on government spending itself. Thus, negative shocks produce more highly persistent effects on spending (spending cuts tend to be more

permanent), while spending adjusts back to normal after an initial expansionary shock (mean reversion). In intuitive notation, let the difference in the PVIR multipliers be: $|\Delta y|^- - (\Delta y)^+$ and in the FEC mutlipliers: $|\Delta y - \Delta g|^- - (\Delta y - \Delta g)^+$, where the superscripts refer to the type of shock. Normally, Δy and Δg will be expected to have the same sign in all cases. However, if spending is subject to mean reversion after the expansionary shocks, then $(\Delta g)^+ < 0$ and the differences at H=4 in particular, which are positive for PVIR-FMs, will be reduced in FEC-FMs and will tend towards insignificance. Thus, a tentative conclusion is that government spending expansions are reversed over a short period of time.

In all, there is strong evidence that the two types of shock are accounted for by almost uniformly significantly different estimated coefficients of our key estimable equation. However, the difference in multipliers is uniformly significant in the case of the PVIR multipliers, but becomes mostly insignificant in the case of the FEC multipliers. Additionally, we uncover evidence to believe that (a) positive shocks have stronger effects over longer periods of time, which would help to explain the averages of these differences, and that (b) the relative persistence of the effects of shocks on output and government spending varies; in particular, spending expansions are subject to mean reversion over a shorter period of time, which would explain why the FEC multipliers at H=4 are insignificant. The significant difference in the estimated coefficients and between the effects of fiscal expansions and contractions in the case of PVIR-FMs allow us to suggest that their effects are not identical, as commonly assumed. As argued in Footnote 44, the endogenous timing of consolidations if anything understates the true differences.

4.5 Concluding Remarks

Fiscal policy activism is enjoying a comeback; there is now greater responsibility placed on fiscal policy to provide a stimulus during recessions. The recession due to the Covid-19 pandemic (ongoing at the time of writing, spring 2022) only serves to heighten the urgency for fiscal policy-based stabilisation. Yet, at the same time that fiscal policy is being called upon to play a stronger activist role, its effects remain debatable.

This chapter is in the line of literature that aims to quantify the effects of fiscal shocks (as well as the shocks themselves). Our point of departure is the expenditure shocks that can be identified by subtracting expected from actual expenditure growth. We utilise quarterly U.S. data, 1986-2017. Most data is standard; the notable addition is expected government expenditure (growth), which has been obtained from the Survey of Professional Forecasters compiled by the Federal Reserve Bank of Philadelphia. Methodologically, in order to obtain impulse responses, we employ the local projections method, coupled with state-dependence of the parameters of the lag polynomial (the states being recession and expansion). The state-dependent parameters are linearly combined by a time-varying weight (transition function) which is contingent on the state of the economy.

We present two sets of fiscal (expenditure) multipliers: the present-value impulse responses of output (PVIR-FMs) of an \$1 unexpected shock for two horizons (H=4,8); this multiplier is our primary focus as it measures the pure output effect of shocks. We also present the present-value output responses minus the effects (present-value impulse responses) of the shock on subsequent government spending itself for the same horizons - the 'fiscal efficacy coefficients', FEC-FMs. The latter type of multiplier has been discussed by some literature, notably Mountford and Uhlig (2009) and Ramey (2019). The argument for it is that it is a measure of financial efficacy (output minus fiscal cost), of the shock, hence the name; on the other hand, its estimate is compounded by the behaviour (cyclicality and/or mean reversion) of government spending, so it is of secondary importance for our purposes. The behaviour of government spending merits further analysis in future work.

All results are in line with theory and intuition. They suggest, that (a) the fiscal consolidations on average have a numerically stronger effect than the expansionary shocks (as well as of opposite signs); and (b) the effects of shocks are in most models countercyclical (in terms of absolute values). All this is in line with the basic premise that different theoretical multipliers (Keynesian vs. neoclassical) apply in different force to fiscal expansions versus contractions (the point of this chapter), and during booms versus recessions (as shown by recent literature). Our results furthermore show (c) persistence of the effects of all shocks. There is also overwhelming statistical significance between the estimated coefficients in the regressions applied separately to negative and the positive shocks. In other words, in terms of estimated coefficients, the regressions are clearly not the same or even similar.

Finally, we have tested for the significance of the difference in the multipliers. The difference is highly significant (as judged by the fraction of the sample in which a time-varying t-statistic is beyond the critical value) in the case of the PVIR multipliers. The FEC multipliers, on the other hand, are not significant much of the time, as the effects on output are compounded by the effects on government spending itself. As argued, the PVIR-FMs is a pure measure of the output effect of shocks, hence we interpret the significance of the differences in these multipliers to formally support our key hypothesis that the effects of contractionary and expansionary shocks are numerically, as well as qualitatively, different. The results in Table 4.5 also suggest that negative shocks have stronger effects on output in a shorter period of time and that they may be more persistent (consolidations are near-permanent). Conversely, the effects of expansionary shocks on output take a longer time to show and that their effects on spending itself are subject to reversal sooner. But these conclusions on persistence and cyclicality are more tentative and will be further explored in future work. Our key point is that we uncover fairly strong evidence that positive and negative spending shock have different effects, in contrast to what is generally assumed (and built into estimation).

The policy implications of these findings are significant: Negative shocks have stronger effects in the short run, and particularly so during recessions, but weaker in the long run than positive shocks. Therefore, from the point of view of a fiscal authority that has the dual objective of providing a stimulus to the economy while at the same time not exacerbating a possible government debt situation (and hopefully improving it), the following strategy appears sensible: Fiscal consolidations are more painful and should best be avoided during the output troughs; instead, limited positive shocks should be applied (most powerful during recessions, as the Figures above attest). When the worst of recessions are over, then moderate consolidations should take place, in order to reverse the effects of expansions on debt and even reduce the latter, as required. In other words, the differential effects of fiscal expansions and consolidations, highlighted here, gives policy-makers a valuable extra degree of freedom. To recall the vintage Tinbergen tools-objectives theorem, where one policy tool (an undifferentiated fiscal shock) would be unable to cope with two conflicting objectives (stimulus and low debt), two essentially different tools (expansions and consolidations) will be better able to solve the dilemma. We leave it to future work to examine whether policy-makers use optimally this strategy; analysing further Hernandez de Cos and Moral-Benito's (2013) finding of the endogenous timing of consolidations. More broadly, further work will examine the effects of rising debt on the degree of fiscal activism and the question of 'fiscal space' (Romer and Romer, 2019).

Chapter 5

Concluding Remarks

In this thesis we considered issues in the field of financial development, macroeconomic volatility an monetary policy.

In chapter 2, using a PARCH framework and data for Brazil from 1870 to 2018 we attempted to shed light on the following questions: What is the relationship between, on the one hand, financial development (domestic and international) and on the other hand, economic growth and (predicted) growth volatility? Are these effects fundamentally and systematically different? Does the intensity and the direction (the sign) of these effects vary over time, in general and, in particular, do they vary with respect to short- versus long-run considerations? Does ownership matter? We find that the main explanatory factors, solely in terms of their negative lagged indirect/direct (short-run) effects on economic growth in Brazil, turn out to be the domestic financial development indicators. Further, we find robust evidence that the U.S. interest rate affects growth positively both indirectly (via its volatility) and directly (both in the short- and long-run). Our results are robust to the inclusion of other economic variables i.e. trade openness and public deficit.

By observing a double negative effect (both direct and indirect) of domestic financial development on output growth the impact of the former on the latter is burdensome. Thus, macro theorists should incorporate the domestic financial development into their growth analysis.

We also find important differences in terms of the direct short-run and long-run behaviour of our key variables. More specifically, we argue that domestic financial development influences growth negatively in the short-run but positively in the long-run, whereas the impact of international financial integration is positive in both cases. Furthermore, the impact of private and public ownership on economic growth tends to be both direct and indirect. However, our parameter estimations highlight the significantly higher (in absolute magnitude) negative indirect and direct short-run effects of public banks (compared to those of private banks) on growth. Finally, trade openness and public deficit influence output growth negatively in the short-run. Our results are robust to the inclusion of population, inflation, and authority score as well as dummy variables.

These findings are interesting but they also matter because they raise a number of new questions that we believe may be useful in motivating future research. Here we highlight two suggestions. Regarding the role of finance in the process of economic development, our findings reinforce a large body of previous research in that we also show a positive impact of financial development on growth in the long-run. We can not however underestimate the fact that Brazil is unique. Put differently, Brazil is an outlier and further research could try to replicate our analysis using the historical experience of other countries (ideally in a panel setting). That is, studying the relationship between financial development and economic growth in a panel of developing countries would strengthen what we know so far. Yet, the data requirements are very heavy indeed, with most developing countries lacking historical data even on key figures, such as the level of gdp, going back to the beginning or middle of the XIXth century. This, of course, does not make this task less important.

The second suggestion refers to a possible methodological improvement, namely the application of the smooth transition error correction model (see Jawadi et al., 2018 for alternative applications). This would clearly represent progress and is something we feel future research should try to address.

The objective of chapter 3 was to further our understanding of the dynamics of relationship between economic growth, financial development and political instability. This chapter revisits the growth-finance nexus using a new econometric approach and new and unique data set. The econometric approach we use, and that has been seldom used in this literature so far, is the logistic smooth transition model (LST). Our unique data set contains annual data for Brazil from 1890 to 2003. The logistic smooth transition framework allows us to study the dynamics of this relationship over the long-run, to evaluate the intensity and direction of its main drivers over time, and to assess how smooth (or not) was the transitions we estimate.

Our main finding is that financial development has a time-varying effect on economic growth, which significantly depends on jointly estimated trade openness thresholds, whereas the effect of political instability (both formal and informal) is unambiguously negative. We show that the finance-growth nexus in Brazil intrinsically depends on political institutions and on the regime-switching factor, which we estimate to be trade openness. Differently from most of the previous literature, which reports a negative short-run relation between financial development and growth, we argue in favour of a mixed time-varying effect (in the short-run). As far as the time-varying results are concerned we detect at least three periods, where financial development has a clearly positive and large effect on economic growth, interestingly all towards the end of our time window. Our estimates also show that a positive impact of trade openness on growth but with interesting variation regarding their size and power. For example, we estimate weaker (although still positive) effects between 1929 and 1933 which correspond to the Great Depression. Finally, our parameter estimates suggest that the change between the regimes tends not to be smooth.

Future studies should investigate the link between political instability and economic growth in a panel of developing countries. A simulation analysis on how growth rate would have been in the absence of some shocks of instability as well as considering the possibility of more than two regimes would clearly represent progress and is something we feel future research should try to address.

Chapter 4 aims to quantify the effects of fiscal shocks (as well as the shocks themselves). Our point of departure is the expenditure shocks that can be identified by subtracting expected from actual expenditure growth. We utilise quarterly U.S. data, 1986-2017. Most data is standard; the notable addition is expected government expenditure (growth), which has been obtained from the Survey of Professional Forecasters compiled by the Federal Reserve Bank of Philadelphia. Methodologically, in order to obtain impulse responses, we employ the local projections method, coupled with state-dependence of the parameters of the lag polynomial (the states being recession and expansion). The state-dependent parameters are linearly combined by a time-varying weight (transition function) which is contingent on the state of the economy.

We present two sets of fiscal (expenditure) multipliers: the present-value impulse responses of output (PVIR-FMs) of an $1 unexpected shock for two horizons (H=4,8); this multiplier is our primary focus as it measures the pure output effect of shocks. We also present the present-value output responses minus the effects (present-value impulse responses) of the shock on subsequent government spending itself for the same horizons - the 'fiscal efficacy coefficients', FEC-FMs.

All results are in line with theory and intuition. They suggest, that (a) the fiscal consolidations on average have a numerically stronger effect than the expansionary shocks (as well as of opposite signs); and (b) the effects of shocks are in most models countercyclical (in terms of absolute values). All this is in line with the basic premise that different theoretical multipliers (Keynesian vs. neoclassical) apply in different force to fiscal expansions versus contractions (the point of this chapter), and during booms versus recessions. Our results furthermore show (c) persistence of the effects of all shocks. There is also overwhelming statistical significance between the estimated coefficients in the regressions applied separately to negative and the positive shocks. In other words, in terms of estimated coefficients, the regressions are clearly not the same or even similar.

Finally, we have tested for the significance of the difference in the multipliers. The difference is highly significant (as judged by the fraction of the sample in which a time-varying t-statistic is beyond the critical value) in the case of the PVIR multipliers. The FEC multipliers, on the other hand, are not significant much of the time, as the effects on output are compounded by the effects on government spending itself. As argued, the PVIR-FMs is a pure measure of the output effect of shocks, hence we interpret the significance of the differences in these multipliers to formally support our key hypothesis that the effects of contractionary and expansionary shocks are numerically, as well as qualitatively, different. The results in Table 4.5 also suggest that negative shocks have stronger effects on output in a shorter period of time and that they may be more persistent (consolidations are near-permanent). Conversely, the effects of expansionary shocks on output take a longer time to show and that their effects on spending itself are subject to reversal sooner. But these conclusions on persistence and cyclicality are more tentative and will be further explored in future work. Our key point is that we uncover fairly strong evidence that positive and negative spending shock have different effects, in contrast to what is generally assumed (and built into estimation).

The policy implications of these findings are significant: Negative shocks have stronger effects in

the short run, and particularly so during recessions, but weaker in the long run than positive shocks. Therefore, from the point of view of a fiscal authority that has the dual objective of providing a stimulus to the economy while at the same time not exacerbating a possible government debt situation (and hopefully improving it), the following strategy appears sensible: Fiscal consolidations are more painful and should best be avoided during the output troughs; instead, limited positive shocks should be applied (most powerful during recessions, as the Figures above attest). When the worst of recessions are over, then moderate consolidations should take place, in order to reverse the effects of expansions on debt and even reduce the latter, as required. In other words, the differential effects of fiscal expansions and consolidations, highlighted here, gives policy-makers a valuable extra degree of freedom. To recall the vintage Tinbergen tools-objectives theorem, where one policy tool (an undifferentiated fiscal shock) would be unable to cope with two conflicting objectives (stimulus and low debt), two essentially different tools (expansions and consolidations) will be better able to solve the dilemma. We leave it to future work to examine whether policy-makers use optimally this strategy; analysing further Hernandez de Cos and Moral-Benito's (2013) finding of the endogenous timing of consolidations. More broadly, further work will examine the effects of rising debt on the degree of fiscal activism and the question of 'fiscal space' (Romer and Romer, 2019).

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