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JAIME DE JESUS FILHO

ESSAYS ON SUPPLY AND DEMAND OF CREDIT IN BRAZIL

FORTALEZA

2020

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Tese apresentada ao Programa de Pós-Graduação em Economia – CAEN, da Universidade Federal do Ceará, como requisito parcial à obtenção do título de Doutor em Economia. Área de concentração: Economia Monetária e Fiscal.

Orientador: Prof. Dr. Paulo Rogério Faustino Matos.

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Aprovada em: ___/___/_____.

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Aos meus amados pais, Cida e Jaime.

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Por último, a Deus por me dar saúde em abundância, de modo que, por diferentes caminhos, vou sendo levado bem além do que poderia imaginar.

“Mas a paixão cega nossos olhos, e a luz que nos dá é a de uma lanterna na popa, que ilumina apenas as ondas que deixamos para trás”.

(Samuel Taylor Coleridge)

RESUMO

Esta tese está dividida em três ensaios. O primeiro aborda a discussão sobre o desembolso de crédito, de 28,6 bilhões de dólares do Banco Nacional de Desenvolvimento Econômico e Social (BNDES), para os governos estaduais brasileiros durante o período de 2009 a 2014. Tenta-se identificar os principais determinantes da alocação de crédito ao longo dos anos e entre estados. Usando um painel dinâmico balanceado para estimar o papel das variáveis técnicas e socioeconômicas. Os resultados sugerem que a necessidade de financiamento dos estados via BNDES não exibe comportamento inercial nem explosivo. A elasticidade de eficiência estimada desse recurso é de 0,20. Além disso, o impacto de uma mudança positiva no status fiscal do Estado leva a um aumento de 2,5% na capacidade de endividamento. Finalmente, descobrimos que os estados mais ricos têm mais sucesso em obter crédito do BNDES.

O segundo ensaio analisa o cenário de solvência do crédito às famílias brasileiras, usando uma versão ampliada do modelo de reação fiscal. Esse modelo nos permite avaliar o impacto das proxies de risco de crédito. O crédito foi desagregado em diferentes fontes de financiamento. Nossos resultados sugerem que o crédito total e não direcionado às famílias é insolvente, devido a causalidade negativa entre a dívida/ PIB e o excedente entre amortização e concessão de crédito como proporção do PIB. Finalmente, o terceiro ensaio utiliza um modelo de desequilíbrio para identificar a escassez no mercado de crédito brasileiro. Analisa-se a evolução da oferta e demanda de crédito e examina-se como essas variáveis se relacionam com os ciclos econômicos. Além do crédito bancário agregado, olha-se para diferentes segmentos de mercados de crédito relevantes ao contexto brasileiro. Verifica-se que o Brasil experimentou excesso de demanda em crédito durante a maior parte da década. Curiosamente, a escassez de crédito é aliviada e não intensificada em momentos de crise: enquanto a oferta de crédito evolui suavemente seguindo uma tendência positiva, a demanda de crédito flutua com a atividade econômica que leva à escassez pro-cíclica de crédito. Quando aplicado a bancos públicos e privados separadamente, o modelo revela que a escassez é significativamente mais grave entre instituições públicas. Comparações entre segmentos de empréstimos indicam que a escassez de crédito é significativamente maior para empresas do que para indivíduos.

Palavras-chave: BNDES, Crescimento do Crédito, Desenvolvimento Econômico, Administração de Endividamento, Escassez de Crédito, Crédito Público e Privado, Oferta e Demanda de Crédito.

ABSTRACT

This thesis has three essays. The first addresses the discussion on the credit disbursement of US$28.6bn from Brazilian National Economic and Social Development Bank (BNDES) to Brazilian state governments during the period from 2009 to 2014. I try to identify the main drivers of the credit allocation in both across state and time series data. Using a dynamic balanced panel to estimate the role of technical and socioeconomic variables, the results suggest that the states' need for financing via BNDES exhibits neither inertial nor explosive behavior. I find an efficiency elasticity of this resource of 0.20. Also, the impact of a positive change in the state fiscal status leads to an increase of 2.5% in the indebtedness capacity. Finally, we find that wealthier states are more successful in demanding credit from BNDES.

The second essay analyzes the solvency scenario for Brazilian household credit by using an extended version of the fiscal reaction approach. This model enables us to assess the impact of credit risk proxies. I disaggregated credit for different sources of financing. Our results suggest that non-earmarked and total household credit are insolvent based on negative causality from debt-to-GDP to surplus between amortization and granting of credit as a proportion of GDP. Finally, the third essay uses a disequilibrium model to identify shortages in the Brazilian credit markets. I analyze the evolution credit supply and demand and examine how these variables relate to economic cycles. In addition to aggregate banking credit, I study different segments of credit markets that are relevant to the Brazilian context. I find that Brazil experienced excess of demand in credit during most of the decade. Interestingly, credit shortages are relieved and not intensified in moment of crisis: while credit supply evolves smoothly following a positive trend, credit demand fluctuates with the economic activity leading to procyclical credit shortages. When applied to public and private banks separately, the model reveals that shortages are significantly more severe among public institutions. Comparisons across borrowing segments indicate that credit shortages are significantly larger for firms than for individuals.

Keywords: BNDES, Credit Growth, Economic Development, Debt Management, Household Credit, Public Credit, Credit Rationing, Supply and Demand of Credit.

SUMÁRIO

1 INTRODUCTION

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The second essay analyzes the solvency scenario for Brazilian household credit by using an extended version of the fiscal reaction approach. This model enables us to assess the impact of credit risk proxies. I disaggregated credit for different sources of financing. Our results suggest that non-earmarked and total household credit are insolvent based on negative causality from debt-to-GDP to surplus between amortization and granting of credit as a proportion of GDP. Finally, the third essay uses a disequilibrium model to identify shortages in the Brazilian credit markets. I analyze the evolution credit supply and demand and examine how these variables relate to economic cycles. In addition to aggregate banking credit, I study different segments of credit markets that are relevant to the Brazilian context. I find that Brazil experienced excess of demand in credit during most of the decade. Interestingly, credit shortages are relieved and not intensified in moment of crisis: while credit supply evolves smoothly following a positive trend, credit demand fluctuates with the economic activity leading to procyclical credit shortages. When applied to public and private banks separately, the model reveals that shortages are significantly more severe among public institutions. Comparisons across borrowing segments indicate that credit shortages are significantly larger for firms than for individuals.

2 ON THE DRIVERS OF BNDES CREDIT TO BRAZILIAN STATE GOVERNMENTS

2.1 Introduction

The main role played by national development banks is providing financing lines in economies facing incomplete and inefficient credit markets. In this context, it is understandable the creation of these banks aiming to deal with serious market failures. Some well-known examples are industrialized countries after the First and Second World Wars. Also, we can quote the nationalist phase of Brazilian developmentalism from 1930 to 1954 or the recent financial liberalization in Latin America in the 90's, addressed in Hira and Gaillard (2011).

However, after reestablishing economic stability, development banks should terminate their activities or remain acting with different responsibilities. Torres and Zeidan (2016) suggest that they can still act as agents responsible for the financing and provision of the commercial banks or insurers of other financial institutions. Moreover, they can work as a source of funds for projects whose social return exceed the private return. Corroborating this statement, Meggison (2004) identified that more than 250 development banks were privatized worldwide in the 80's. Nevertheless, according to Bruck (1998) there were in the same period approximately 520 national development banks operating in 180 countries, with Latin American and Caribbean countries as the most prominent, with 152 banks.

In this discussion, Brazil is an interesting case. The democracy and economic stability have been recently established and both are often jeopardized by misguided political and economic policies. This scenario seems to justify maintaining institutions that enable the public financial sector to design long-term financing mechanisms for firms. Theoretically, the purpose is to offer resources for projects whose risk premium is too high to attract private investment. Some examples are public safety, education, sanitation infrastructure, urban mobility, innovation and technology. In practice, in Brazil there are two big commercial public banks, besides one national and two regional development banks.

In this paper, we contribute to this debate by studying specifically the Brazilian National Economic and Social Development Bank (BNDES). Established in 1952, this bank remains controlled 100% by the federal government and is one of the largest in the world, with total assets of more than US$ 370 billion in 2014.

The literature on BNDES is extensive. A theoretical discussion on the role of this bank is proposed by Musacchio and Lazzarini (2014). They address relevant issues as transparent management, professional governance based on risk management models and

regulatory frameworks. Concerning related empirical studies, De Souza et al. (2015) provides an updated overview. Using a sample of 919 paper, this survey identifies a concentration of most of the studies addressing the BNDES role as a creditor institution for firms.

Related to this issue, Bonomo *et al*. (2015) find that BNDES favors grant of credit to large, traditional low-risk companies, with insignificant impact on investment spending. The bank also works as a shareholder of firms. In Inoue et al. (2013), the authors find that during the period from 1995 to 2009, the bank did not systematically select companies based on past performance or other financial indicators. In Lazzarini *et al*. (2015), during the period from 2002 to 2009, donations to losing candidates for positions subject to majority rule (president, senator, and state governor) appear to reduce BNDES equity for higher margins of victory. To summarize, this literature on the drivers of BNDES loan and equity allocations suggests that firms' selection process does not necessarily follows technical criterion.

According to De Souza *et al*. (2015) there are a few studies on the relationship of BNDES with the public sector, in special with subnational governments. Relative to the credit to companies, the credit for the public sector is small. During the period from 2009 to 2014, the credit from BNDES to firms was US$ 200 billion, while municipal governments received US$ 3.1 billion. Federal District received almost US$ 0.3 billion. Considering only state government projects, the disbursement from BNDES was US$ 28.6 billion.

Here we contribute to this discussion trying to identify the main drivers of BNDES credit disbursement to Brazilian states governments. We claim originality in modeling BNDES as a planner that has some goals, as improving socioeconomic conditions in underdeveloped states. However, we need to consider that the bank faces some technical constraints and it cannot lend too much to state governments that spend a lot and spend badly. In other words, we want to answer whether resource allocation from BNDES to states follows or not technical and socioeconomic criteria.

We follow methodologically Hansen and Sulla (2013) and Matos (2017b) proposing a parsimonious linear dynamic panel model to estimate the impact of technical and socioeconomic variables on BNDES credit to state governments. We find that the resource allocation as a ratio of each government revenue does not exhibit inertial nor explosive behavior. Our results suggest that an increase in technical efficiency, as well as a positive change in the fiscal situation, are able to affect positively credit grant a year ahead. Also, we show that wealthier states are more successful in demanding credit from the BNDES, regardless of the level of income inequality.

This paper is structured as follows. In the next section, we analyze credit from BNDES. Section 3 illustrates the setup of the approach. Section 4 analyses dataset and reports the main findings. Section 5 brings the final remarks.

2.2 BNDES and government states

2.2.1 Credit disbursement

The credit activity of Brazilian subnational entities is not a recent phenomenon. Maia and Saraiva (2012) report detailed operations with international organizations developed more than one century ago. However, in recent years there has been a more frequent experience of obtaining alternative sources from national public and private banks, as well as from paradiplomatic experience.

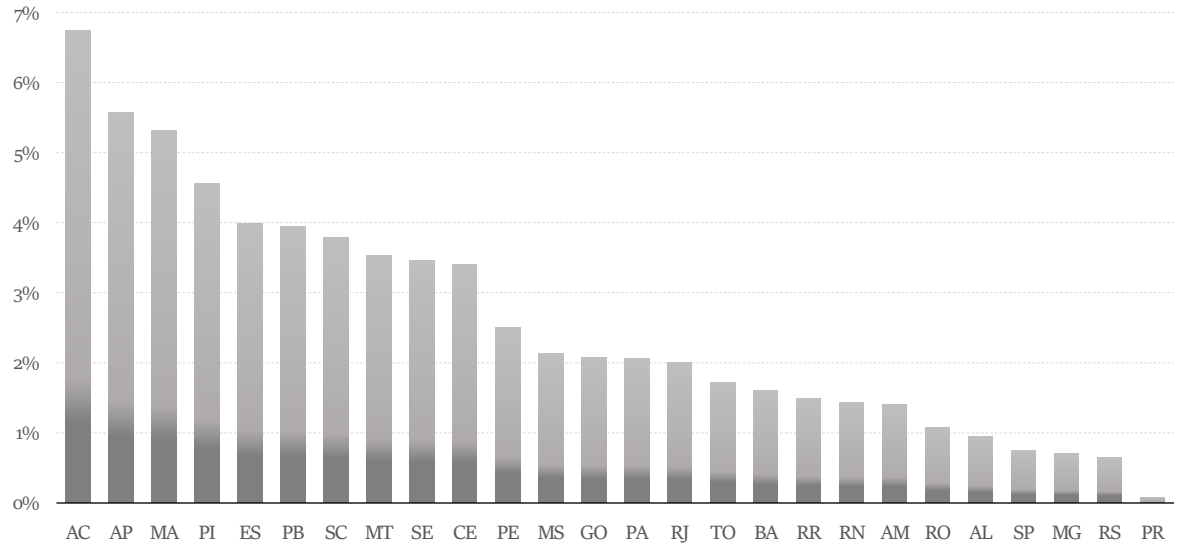
The practice of obtaining national credit is more common and well known, often associated with specific social programs or linked to Public-Private Partnerships (PPP). These operations mostly contracted in local currency, are usually obtained from BNDES, Bank of Northeast, Bank of Amazonia or from commercial banks.

According to data from the Transparency Portal of the BNDES, considering only state government projects, the nominal disbursement from BNDES was US$ 28.6 billion during the period from 2009 to 2014. This is equivalent to a disbursement of US$ 145 per inhabitant, considering the mean population from 2009 to 2014 of those 26 states.

This resource allocation ranged from US$ 1.2 billion in 2011 to US$ 9.2 billion in 2012. According to Figure 1 the credit distribution has a huge variation also in the cross-state dimension. This figure reports mean values for the ratio credit from BNDES to total revenue of the state, in the period ranging from 2009 to 2014. The analysis of the ten most dependent states of this credit shows that five of them are from the Northeast region, while states in the South region are among the least dependent.[1]

[1] Time series data of credit from BNDES to revenue for all states from 2009 to 2014 are available in Table A1 (Appendix A).

Figure 1 – Credit from BNDES as a percentage of total revenue for the federative unit, excluding Federal District



Source: BNDES.
Note: Average levels (from 2009 to 2014) of financing dependency measured by the ratio between the contemporary annual values of credit granted by BNDES and the corresponding total revenue of the government state.

Although the literature usually reports credit to GDP, credit to total revenue is useful to measure state dependence, since its revenue is mainly composed of transfers and taxes. This also shows the heterogeneity in the revenue composition of the state governments. According to Matos (2017b), the states in the South and Southeast regions have more than 60% of the total revenue coming from tax. In the North region, this share ranged between 18% and 45% during the period from 2004 to 2013, except for Amazonas. Regarding the relative volume associated with paradiplomatic activity of the states, the majority ranged between 0% and 2%.

2.2.2 Technical constraints

BNDES, as a development bank controlled by the federal government, must be aligned with the guidelines followed by the main worldwide development agencies. In this sense, we want to see whether BNDES conforms or not to two technical pillars in terms of the evaluation of credit demands by state governments.

First, we assume that BNDES is obliged to account for governance based on risk management models and regulatory frameworks. Thus, the first pillar of extreme importance in the formulation of public policy involving state governments refers to the fiscal austerity.

This is a subject that has already been contemplated both in the academy and in the public sector management in practical terms. One may observe the Law of Fiscal Responsibility (Complementary Law Nº. 101, dated 05/05/2000). This instrument aims to establish, in a

national regime, parameters to be followed regarding public expenditure of each Brazilian federative entity, imposing budgetary restrictions that preserve its fiscal situation.

Concerning indebted states that continue investing in periods of crisis, Manoel, Ranciaro Neto and Monteiro Neto (2016) argue that: "[…] when a state government has a high level of public debt and a weak fiscal situation, private companies may feel insecure with the possibility of facing high tax burdens and, therefore, decide to leave the territory for another with less taxes. In this case, the increase in investment may not be welcome, as it may be possible to associate an increase in investment (through debt) with fiscal insolvency." Thus, following those authors, we use the Fiscal Rating Index (*FRI*) as a measure of technical constraint to be considered by BNDES.

In short, FRI is a metric obtained from eight economic and financial indicators with different weightings that captures the stock and the flow of the state indebtedness. It is useful to characterize the fiscal situation and the credit risk of the state. According to the Decree no. 360 of the National Treasury Secretary, if a state government has a D+, D, or D- rating, it can only borrow with the authorization of the Minister of Finance; if it has a C+, C, or C- rating, it can only borrow with the authorization of the National Treasury Secretary; and in the case of a B+, B, B-, A-, A, or A+ rating, it is technically apt to undergo a credit transaction without additional authorization. [2]

Regarding the second technical driver, the concept of efficiency is recurrent in international theoretical and empirical literature comparing countries, regions, states or cities. The literature proposes measuring technical efficiency in terms of the allocation of resources and generation of social welfare. International institutions, such as the International Monetary Fund (IMF) and the World Bank, publicly express concern about economies or states characterized as inefficient. Therefore, there is an extensive international literature on this issue. For instance, Tanzi and Schuknecht (1997) provide an empirical application to analyze 18 developed and industrialized countries, combining public expenditures that should be able to provide a given set of socioeconomic indicators. Despite the relevance, it seems there is not an extensive literature applied to Brazil possibly due to the complexity of measuring efficiency. One may see Tanzi (1974) for a deeper understanding of limitations in measuring efficiency.

Aiming to address here the effects of efficiency in terms of resource and social welfare, we follow Matos (2017a). This is the most recent and most complete study on the efficiency of the 27 Brazilian states, including the Federal District, after the implementation of

[2] These ratings from 2009 to 2013 used here were extracted from Manoel, Ranciaro Neto and Monteiro Neto (2016) and they are available in Table A2 (Appendix A).

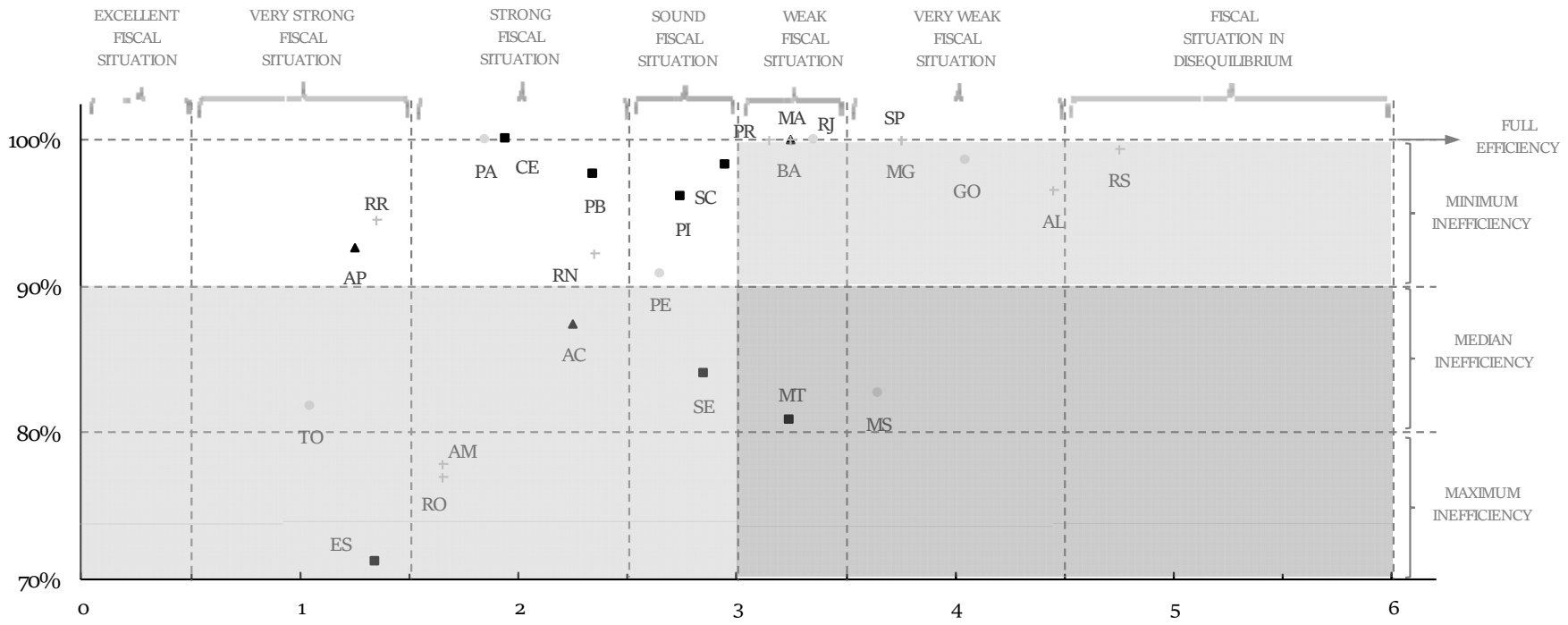
the Fiscal Responsibility Law. The paper uses data envelopment analysis to model the process of social welfare generation by federation units.

The first innovation in Matos (2017a) is the use of input sources associated with traditional revenues, such as transfers and taxes, as well as alternative sources of funding via national credit and paradiplomacy. As a result of this process, the state should provide goods and services associated with socioeconomic variables such as health, violence, demographics, education, and basic infrastructure. The main finding in that study is to provide a technical efficiency frontier (or measure), TE, for each state in each year, from 2004 to 2013. This variable may assume any positive value up to 100%. [3]

Figure 2 shows the average values, from 2009 to 2013 of both technical variables used here to explain credit allocation from BNDES to government states.

[3] These technical efficiency measures from 2009 to 2013 used here were extracted from Matos (2017b) and they are available in Table A3 (Appendix A).

Figure 2 – Technical constraints of BNDES credit concession to the federative units, excluding Federal District



Source: Original data extracted from the STN, Institute of Economic and Applied Research (IPEA), Brazilian Institute of Geography and Statistics (IBGE), Single Health System (SUS), Human Development Atlas and BNDES.

Notes: a) This figure plots the dispersion of the mean values calculated during the period from 2009 to 2013 for the fiscal rating index (FRI) of the states (horizontal axis) and technical efficiency (vertical axis). b) FRI calculated by Manoel, Ranciaro Neto, and Monteiro Neto (2016). As per Decree 306 of the MF: FRI between 0 and 0.5 = Excellent; FRI between 0.5 and 1.5 = Very Strong; FRI between 1.5 and 2.5 = Strong; FRI between 2.5 and 3.0 = Sound; FRI between 3.0 and 3.5 = Weak; FRI between 3.5 and 4.5 = Very Weak; and FRI between 4.5 and 6.0 = Disequilibrium. Invoice of a certain state in a certain year corresponds to the weighted mean of the invoices in the previous 3 years. c) Technical efficiency (TE) extracted from Matos (2017b), calculated through Data Envelopment Analysis (DEA). d) States denoted with a dark triangle have financing dependency levels greater than 5.1%; states represented by a dark square have financing dependency levels between 3.4 and 5.1%; states denoted with a clear circle have financing dependency levels between 1.7 and 3.4%; and states indicated by a clear cross have financing dependency levels less than 1.7%.The levels of dependency on the BNDES financing are quantified via the mean (from 2009 to 2014) of the ratio between the contemporary annual values of credit granted by the BNDES and the corresponding total revenue of the state.

In this figure, states indicated by a dark triangle have financing dependency levels greater than 5.1%; states denoted with a dark square have financing dependency levels ranging from 3.4 to 5.1%; states indicated by a clear circle have financing dependency levels between 1.7 and 3.4%; and states represented by a clear cross have financing dependency levels less than 1.7%.

The light gray area suggests attention in the concession of credit. Given the inefficiency in the use of resources, Acre, Sergipe and Espírito Santo are in this attention area. They are moderately dependent on this credit. The dark gray area indicates that the loan should be inadvisable. Mato Grosso is located here, given its weak fiscal situation and medium inefficiency. Most heavily dependent states are located in the white color area characterized by the favorable to the credit grant from BNDES based on both technical constraints.

2.2.3 Socioeconomic drivers

Although it is not consensual, there is an understanding that one of the main goals of any development bank is generating wealth for the economy in which it operates and its effective distribution. In this sense, development banks should prioritize the allocation of credit to firms and public sector of more neglected regions. These banks should concentrate on activities whose social return exceeds private return, such as those related to public safety, education, basic sanitation infrastructure, urban mobility, innovation, and technology.

According to the most recent BNDES Annual Reports, it is clear that one of the purposes is giving proactive support to states, municipalities and to the federal government's Investment Partnership Program (PPI), in order to complement its operation in infrastructure. More specifically in the report from 2016, BNDES may prioritize the state concessions program of the sanitation sector, due to its potential positive impacts on the Brazilian population's quality of life, for instance. Moreover, it is also desirable avoiding the problems of agency and favoring state or municipal governments and groups of companies or specific sectors, aspects inherent in the public machine.

This concern from BNDES in social terms with Brazil proceeds. The country has continental dimensions and is quite uneven based on several indicators. According to data set used in Matos (2017b) available from 2004 to 2013, the state with the lowest poverty rate in the North and Northeast regions (Rondônia with 20.3%) has almost twice the number of individuals in conditions unsuitable for survival than in the state with the highest poverty rate in the other regions. In Maranhão, more than 40% of the population is living in poverty.

This situation was exacerbated by the fact that the private households in the North,

Northeast and also Central-West regions, with exceptions of Distrito Federal, Roraima, and Sergipe, were characterized by a lack of adequate sanitation in very high percentages. While in São Paulo and the Distrito Federal, more than 90% of the homes had adequate sanitation, in Tocantins and Alagoas, just over 30% had this basic condition of decent housing. On average, in the most deprived areas, less than 55% of the homes had sewage, whereas in the South and Southeast regions the values exceeded 80%.

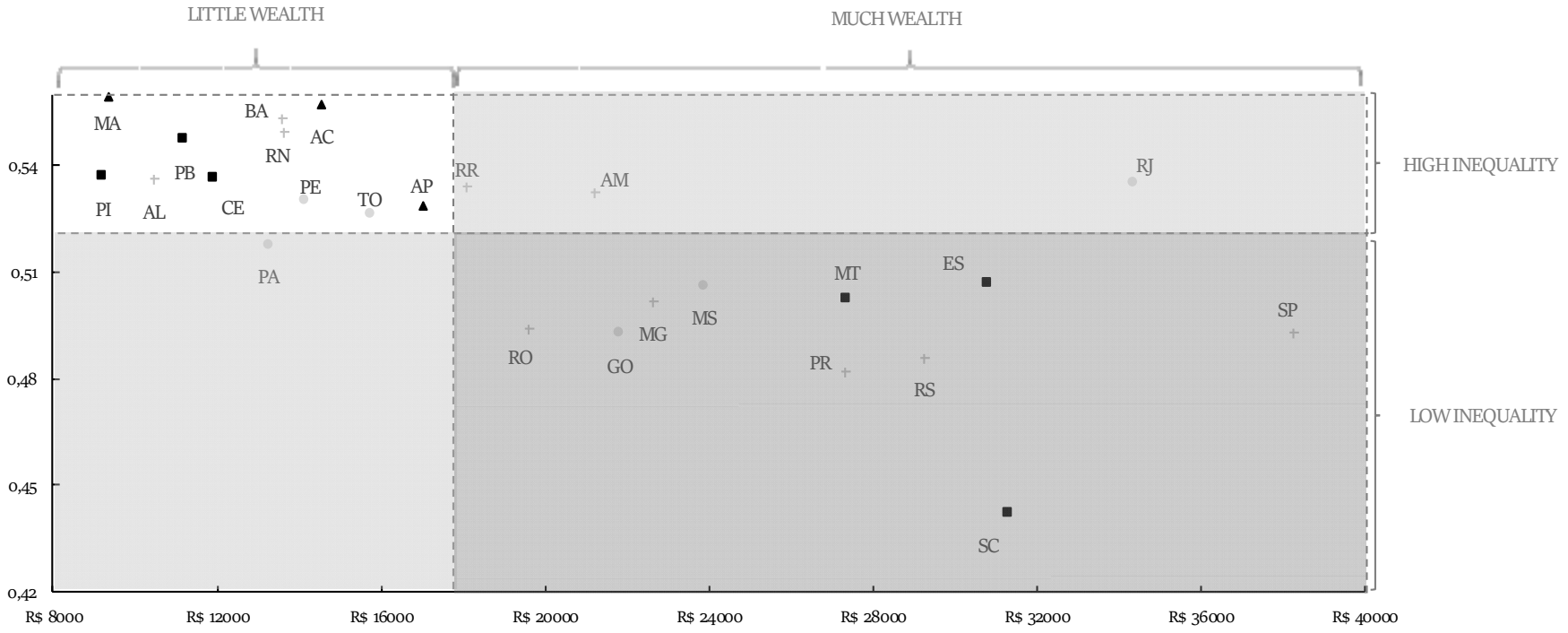
In this context, when a state government wants to obtain financial resources from BNDES it would be appropriate for both government and bank to observe socioeconomic characteristics of the respective state. In other words, observing the levels of the main social and macroeconomic indicators can work as a proxy for the real need for investment in infrastructure and subsequent improvement of social welfare. Given that, we have decided to measure the effect of the two metrics widely used in the literature on development. We use real per capita Gross Domestic Product (GDP) and the income inequality given by Gini coefficient.[4] We believe they are capable of reflecting the social welfare of the Brazilian states.

Figure 3 summarizes the situation of each state based on both socioeconomic drivers.

The variables plotted in this figure supposedly define states' needs for financing via the BNDES combined with the level of indebtedness via the BNDES. Once again, states denoted with a dark triangle have financing dependency levels greater than 5.1%; states represented by a dark square have financing dependency levels between 3.4 and 5.1%; states indicated by a clear circle have financing dependency levels between 1.7 and 3.4%; and states denoted by a clear cross have financing dependency levels less than 1.7%. There are no states with strong demand in the light gray areas, and most of the states with a strong need for financing are perceived as poor and unequal. However, in addition to Santa Catarina, Espírito Santo and Mato Grosso once again appear as dependent on BNDES financing, even though they are among the richest and least unequal states.

[4] Inequality and wealth data for each state from 2009 to 2013 used here are available respectively in Table A4 and Table A5 (Appendix A).

Figure 3 – Socioeconomic drivers of BNDES credit concession to the federative units, excluding Federal District



Source: Original data extracted from the IPEA and IBGE.

Notes: a) This figure plots the dispersion of the mean values calculated during the period from 2009 to 2013 for the real GDP per capita of the states (horizontal axis) and the Gini coefficient (vertical axis). b) Real GDP in constant R$ in December 2013, using the IPCA. Rich states have a mean per capita wealth greater than the national median value (excluding the DF) of R$ 17,559.42, whereas poor states have mean per capita wealth less than the national mean (excluding the DF) of R$ 24,788.65. c) Very unequal states have a mean Gini value greater than 0.52, whereas states with little inequality have a mean Gini value less than 0.52. d) States denoted by a dark triangle have financing dependency levels greater than 5.1%; states indicated by a dark square have financing dependency levels between 3.4 and 5.1%; states represented by a clear circle have financing dependency levels between 1.7 and 3.4%; and states denoted with a clear cross have financing dependency levels less than 1.7%. The levels of dependency on BNDES financing are measured by the mean (from 2009 to 2014) of the ratio between the contemporary annual values of credit granted by the BNDES and the corresponding total revenue of the state.

2.3 Economic modeling

Based on the previous discussion, our intent is modeling the behavior of BNDES as a planner that targets to improve socioeconomic conditions in underdeveloped states while it faces technical constraints.

Given the limitations of the data available, we must follow the approaches most commonly used in the empirical literature. More specifically, we are aligned methodologically to the research developed by Kiss *et al*. (2006), Hansen and Sulla (2013) and Matos (2017a). Even closer to our work, Matos and Correia Neto (2017) propose to model the drivers of household credit from 2004 to 2013. In Matos *et al*. (2015) the authors analyze the determinants of household delinquency heterogeneity in Brazil.

Formally, we want to model the credit from BNDES to a given state government i in year t, $BNDES_{it}$, as a proportion of its respective total revenue, TR_{it}. This proxy of the financing need of state i in year t is given by $\frac{BNDES_{it}}{TR_{it}}$.

We propose to test whether this behavior is inertial and explosive by adding the lag of the dependent variable in our specification Moreover, we also intend to estimate the effects of a previous fiscal effort and efficient resource allocation by the state government. We do it by measuring the role played by FRI_{it-1} and TE_{it-1}, respectively. Our approach also enables us to infer about socioeconomic criteria of BNDES by measuring the parameters associated to GDP_{it-1} and $GINI_{it-1}$. The empirical model for the BNDES credit can be summarized as follows:

$$\frac{BNDES_{it}}{TR_{it}} = \alpha + \gamma \frac{BNDES_{it-1}}{TR_{it-1}} + \delta FRI_{it-1} + \vartheta TE_{it-1} + \varphi GDP_{it-1} + \theta GINI_{it-1} + \varepsilon_t \qquad (1)$$

We use the GMM estimator for linear dynamic panel data models to estimate (1).

Concerning the estimation of our approach, the econometric technique of panel data estimation is the most suitable method for this empirical exercise. First due to the number of available time series data points being relatively small given the number of observation units, the Brazilian states. Second, considering the infeasibility of a characteristic study time series analysis, the panel technique enables us to model the behavior of the states over time and the influences between the states. Owing to these characteristics, the estimation of panel data is more appropriate because of the effects resulting from omitted, latent, or unobserved variables. Another advantage relative to single-dimension estimates is the quality of the inference based on more efficient estimated parameters, which is due to the higher number of degrees of freedom. We must mention that there is less concern with multicollinearity — a common violation in exercises in which lagged variables are employed as explanatory variables. Finally,

given the scarcity of empirical and theoretical literature on the drivers of credit from national development banks to federative entities, we believe having offered a relevant empirical contribution to this discussion based on the estimation of this ad hoc model.

2.4 Empirical Exercise

2.4.1 Database

The greatest limitation of this type of study is the availability of the data for all the states for several years, considering that some of these variables are calculated through specific methodologies and therefore they are available only in scientific articles for certain periods of time and not updated frequently.

In the case of the Fiscal Rating Index (FRI), the most current data available for all states date from 2009 to 2014, while the technical efficiency is available for the sample from 2004 to 2013. On the other hand, data from the BNDES besides inflation, population, GDP, total revenue, and Gini data are available for each year of the last few decades. Thus, the broadest available time span ranges from 2010 to 2014, based on the lagged annual data from 2009 to 2013, in accordance with the model described in equation (1). Table 1 reports the mean values of endogenous and exogenous variables.

One can see the heterogeneity of the dependence on public financing of the states, with regional bias: Northeastern states have a credit-to-total-revenue ratio on the order of eighty times those reported for states in South region. The heterogeneity of the explanatory variables is also evident. Considering the socioeconomic factors, the income equality and real per capita GDP are considerably higher in the South and Southeast regions. Gini coefficient in Sergipe is 30% greater than in Santa Catarina. In Maranhão, the *per capita* wealth is almost 1/4 that of São Paulo.

With regards to technical determinants, there is an interesting inversion of the scenario. In terms of ratings, only states in the Northeast and North regions are classified as strong. The entire Southeast, with the exception of Espírito Santo, has a weak or very weak fiscal situation. Finally, the technical efficiency does not suggest any regional pattern, ranging from 71% in Espírito Santo to 100% in various states located in diverse regions.

Table 1 – Summary statistics

State	Endogenous variable	Technical and socioeconomic variables			
	BNDES credit to Total Revenue Source: BNDES	**Technical Efficiency** Source: Matos (2017b)	**Fiscal Rating Index** Source: Manoel et al. (2016)	**Gini coefficient** Source: IPEA	**Real per capita GDP** Source: IBGE
North region					
Acre	6.75%	87.48%	2.25	0.5570	R$ 14,542.17
Amazonas	1.41%	77.88%	1.65	0.5323	R$ 21,219.61
Amapá	5.57%	92.70%	1.25	0.5288	R$ 17,024.33
Pará	2.07%	100.00%	1.85	0.5177	R$ 13,263.31
Rondônia	1.08%	76.98%	1.65	0.4941	R$ 19,594.14
Roraima	1.49%	94.58%	1.35	0.5339	R$ 18,094.51
Tocantins	1.73%	81.84%	1.05	0.5263	R$ 15,745.85
Northeast region					
Alagoas	0.95%	96.58%	4.45	0.5360	R$ 10,460.00
Bahia	1.61%	100.00%	3.25	0.5531	R$ 13,576.30
Ceará	3.41%	100.00%	1.95	0.5360	R$ 11,924.84
Maranhão	5.32%	100.00%	3.25	0.5592	R$ 9,375.86
Paraíba	3.94%	97.60%	2.35	0.5471	R$ 11,217.04
Pernambuco	2.51%	90.84%	2.65	0.5299	R$ 14,134.15
Piauí	4.57%	96.02%	2.75	0.5366	R$ 9,206.47
Rio Grande do Norte	1.43%	92.22%	2.35	0.5491	R$ 13,639.82
Sergipe	3.46%	83.94%	2.85	0.5602	R$ 14,895.60
Center West region					
Goiás	2.07%	98.62%	4.05	0.4926	R$ 21,822.07
Mato Grosso	3.54%	80.80%	3.65	0.5019	R$ 23,891.47
Mato Grosso do Sul	2.13%	82.66%	3.25	0.5062	R$ 27,367.95
Southeast region					
Espírito Santo	3.99%	71.14%	1.35	0.5068	R$ 30,809.54
Minas Gerais	0.70%	100.00%	3.75	0.5015	R$ 22,645.50
Rio de Janeiro	2.01%	100.00%	3.35	0.5351	R$ 34,338.20
São Paulo	0.76%	100.00%	3.75	0.4929	R$ 38,276.66
South region					
Paraná	0.08%	100.00%	3.15	0.4817	R$ 27,325.26
Rio Grande do Sul	0.65%	99.36%	4.75	0.4860	R$ 29,261.65
Santa Catarina	3.78%	98.20%	2.95	0.4421	R$ 31,316.64

Source: Original data extracted from the BNDES, IPEA and IBGE. Author´s calculation.

Notes: a) Mean value calculated during the period from 2009 to 2013 for the exogenous variables and during the period from 2009 to 2014 for the endogenous variable. b) According to Decree 306 of the MF: IRF between 0 and 0.5 = Excellent; IRF between 0.5 and 1.5 = Very Strong; IRF between 1.5 and 2.5 = Strong; IRF between 2.5 and 3.0 = Good; IRF between 3.0 and 3.5 = Weak; IRF between 3.5 and 4.5 = Very Weak; and IRF between 4.5 and 6.0 = Disequilibrium. c) Invoice of a given state in a given year corresponds to the weighted mean of the invoices in the previous 3 years.

2.4.2 Results

Table 2 reports the values obtained from the estimation of the model described in (1) using a dynamic balanced panel, in accordance with Arellano and Bond (1991). Concerning

other specifications, we eliminate the fixed effects of the states via differentiation and using White's variance-covariance matrix in the temporal dimension. The definition of the set of instruments for estimation of the dynamic framework via the generalized method of moments (GMM) in two stages of iteration follows this literature. We employ the lagged dependent variable itself as a dynamic instrument and the other explanatory variables with a lag like other instruments without transformation.

Table 2 – Estimation of the dynamic balanced panel

Main results		
	BNDES credit to Total Revenue in *t*	
BNDES credit to Total Revenue in *t-1*	-0.3688 **	[0.0000]
Fiscal Rating Index in *t-1*	-4.9981 **	[0.0000]
Technical Efficiency in *t-1*	0.1980 **	[0.0000]
Gini coefficient in *t-1*	-8.8561	[0.3334]
Real GDP per capita in *t-1*	0.0006 **	[0.0001]
Complementary results: Arelano and Bond test for autocorrelation		
M-statistic for AR(1)	-0.9924	[0.3210]
Complementary results: overidentifying restrictions		
Instrument rank	26	
J-statistic	22.1190	[0.3927]

Source: Author´s calculation.

Notes: a) Dynamic balanced panel with the 26 states, from 2010 to 2014. b) Arellano and Bond's (1991) efficient GMM estimate with fixed effects in the cross section and White's variance-covariance matrix in the temporal dimension. c) Instrument set: lagged dependent variable itself and the other explanatory variables as the dynamic instrument. d) Respective p-values are reported in the brackets. * p-value<0.05. ** p-value<0.01.

The results initially suggest that there is neither explosive nor inertial behavior that follows a vicious cycle. This is because of the negative significant result of the coefficient associated with the lagged endogenous variable. This finding lets us infer that a 1% increase in the dependence on credit as a percentage of the total revenue in year $t-1$ involves a reduction of 0.37% in this same dependence in year t.

Considering the drivers that should be signaling the technical assessment of the state request by the BNDES, we find that a 1% increase in their technical efficiency in $t-1$ sends a positive signal about being able to borrow from the BNDES at approximately 0.20% in t. On the other hand, the strongest evidence is related to the austerity and consequent indebtedness capacity. We know that the better the fiscal situation, the lower the value of FRI.

The improvement of the fiscal situation means a positive change in the subsequent rating among the existing 12 (A+ to D-) which is associated, on average, with a reduction of 0.5 in the FRI. We find that a positive change in the subsequent rating enables an increase in the subsequent year of 2.5% in the indebtedness via the BNDES as a proportion of the total revenue. We must emphasize that changes between qualitative classifications are even more relevant for simplifying the concession process, owing to states no longer depending on the Ministry of Finance or the National Treasury Secretariat.

In terms of socioeconomic determinants, the intuition suggests that poorer and more unequal states should resort to this line of credit. However, we find that an increase of R$ 1,000.00 (in constant R$ for December 2013) in the per capita GDP in $t-1$ makes a state more successful when requesting credit from the BNDES in t at 0.60% of its total revenue. Also, we find that the Gini coefficient does not seem to be significant at 5% level.

As complementary results, we also report in Table 2, the results for Sargan-Hansen test used for testing the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. [5] We fail to reject the null hypothesis that such restrictions are valid. Moreover, following Arellano and Bond's (1991) test we fail to reject the null hypotheses of no autocorrelation of the error term for AR(1) process.

2.4.3 Discussion of the results

There is no consensus regarding the relationship between the credit market and development indicators, nor even about the causality between infrastructure and economic growth. Straub (2008) reports some evidence for developing economies while Amann *et al*. (2016) provide recent evidence for Brazilian states. These authors find that increases of 1% in spending on investments in the Brazilian states lead to GDP growth of 0.11% and a 0.072% increase in the corresponding GDP per capita.

An implication of this finding is that Brazilian states with worse levels of socioeconomic variables should take precedence for this timely and accessible source of funds with the objective of maintaining its levels of infrastructure investments. Also, they should prioritize political and human capital to obtain credit to complement their limited tax revenues, no longer just being dependent on federal government transfers.

In this context, the case of Rio Grande do Norte is emblematic. This state is of the poorest states with higher income inequality. The government of this state exhibit a strong and

[5] One must see Sargan (1958) and Hansen (1982) for more details on this test.

robust fiscal situation together with a mean technical efficiency greater than 92%. This set of features enables this state to incisively resort to the BNDES as a source of funds and thus have attended such requests for credit. This favorable combination cannot result in a credit to total revenue of 0.00% in 2011 and 2012 and only 0.16% in 2014. On the other hand, the symbolic exception characterized by Mato Grosso, the eighth state with the highest credit ratio weighted by total revenue. It is necessary to review, or at least to explain this level of credit disbursement (8% of total credit from BNDES to 26 states) to a state with low mean efficiency and weak fiscal situation (C+ in all years of the sample).

We suggest that the concession of credit to the public sector, in addition to being responsible and judicious, also seems to be responsible and judicious. In other words, all the legal and institutional rigor in the disbursement of credit to each state does not seem to be sufficient if there is not total transparency and wide social disclosure of these policies. In summary, the evidence from this empirical exercise about the other side of the coin in this uncooperative game suggests that the procedure for the assessment and subsequent grant of credit by the BNDES should remain satisfying the relevant legal provisions and rewarding the austerity and efficiency of the states.

2.5 Concluding Remarks

In the extensive and burgeoning body of literature on public finance applied to countries, the relevance of the probability of default in a credit operation is unquestionable. Dimitrakpoulos and Kolossiatis (2016) is a very interesting and recent study addressing this issue. Analogously, the concept of efficiency is recurrent in international theoretical and empirical literature comparing countries, regions, states or cities, as one can see in Tanzi and Schuknecht (1997).

Despite this perception, sovereign credit ratings of Brazilian states have been rarely applied as a binding restriction. Moreover, it is even rarer seeing a study using the efficiency of the allocation of resources by the state governments as a driver useful to draw any public policy involving such subnational entities in Brazil.

In this context, our first and specific purpose is measuring the role of both technical constraints in the relationship of BNDES and Brazilian state governments. We find that the Ministry of Finance, the National Treasury Secretariat, and the BNDES are aligned with the guidelines followed by the main development agencies worldwide. In other words, we find that they seem to be approving credit to the state governments in accordance with indicators of ability to pay and efficiency of allocation. Also, we find that BNDES favors grant of credit to

wealthier states.

We must highlight the relevance of our innovative contribution about the relationship of BNDES and state governments given the shortage of related theoretical and empirical literature, as emphasized by the survey developed by De Souza *et al*. (2015). At the same time, we need to recognize that our intuitive but ad hoc framework has limitations and still does not address some specific issues already mentioned in the literature about BNDES as a creditor institution of firms, such as the significance of political drivers reported in Carvalho (2014).

Our contribution is supposed to provide researchers to combine it with other approaches aiming to better understand related phenomena, as paradiplomacy. According to information provided by the Secretariat of International Affairs (SEAIN), the total value of the 511 credit operations contracted by the Brazilian public sector with multilateral and bilateral sources over the period from 1980 to 2009 reached US$ 71.9 billion. Of this amount, approximately US$ 20.9 billion were contracted directly by the state governments through 204 credit operations.

Moreover, this paper is useful to revisit the discussion on a broader and more complex issue: Brazilian federal pact.

The Brazilian state since the implementation of federalism assumes the tripartite model. Federal, state and municipal entities are endowed with governments themselves. However, most of the resources are collected by the federal government and later passed on to other federative entities. According to data available at the STN, almost US$ 570 billion were passed on to state and municipal governments during the period from 2009 to 2014.

In the specific case of the relationship between the federal government and the state governments, there are basically two ways of distributing resources. First, constitutional transfers, whose criteria are expressed in the federal constitution. Second, the voluntary transfers that are under the responsibility of the federal government that has autonomy to define the amount, the states and the public policies contemplated.

With regards to these voluntary transfers to states, they have ranged from US$ 2.6 to US$ 4.4 billion per year from 2009 to 2014. On the one hand, there is transparency about the values that are public. However, we can say little about its determinants, for instance, since there is no legal contingency restricting their discretion. According to Costa *et al*. (2011) there is considerable heterogeneity in such transfers of resources to the states, which in theory demonstrates a possible lack of criterion in the selection. Moreover, they find that for the period from 1997 to 2008 the political variables (governor's party, electorate, and percentage of

members of coalition parties in support of the federal government) were significant to explain cross-state voluntary transfers, as well as the region where the state is located.

To summarize. There seems to be a shortage of meritocracy not only in the literature on public finance in Brazil but in the management of the public sector. In this sense, we claim that, although Brazil is a recent democracy, it is unacceptable that the decision-making, the formulation and the implementation of systemic public policies involving Brazilian states, cities and federal government do not follow explicitly technical criteria.

3 HOUSEHOLD CREDIT BUBBLE IN BRAZIL: THE UNBEARABLE LIGHTNESS OF HAVING

3.1 Introduction

In the early 90's Latin American economies have experimented a financial liberalization by moving toward an open and market-based development model instead of a state-based model. The context of this change is well described in Stallings and Studart (2006), while Matos (2017b) empirically adds to discussion about its drivers. In this heterogeneous group comprised by twenty emerging countries, the specific case of Brazil is very interesting because of its idiosyncrasies.

First, referring to income, Brazilian economists used to say: "there are two nations in the same territory". However, according to Matos *et al*. (2013) there is also a discriminatory credit policy evidenced by the formation of two clubs characterized by a regional bias: states located in the Northeast and the North regions are predominantly in the second club. Matos and Correia (2017) study this cross-state heterogeneity and find that the demand for credit plays a more important role than supply from 2004 to 2013. This evidence corroborates De Jesus Filho and Matos' (2017) previous finding based on a disequilibrium model, which identified shortages in this credit market from 2000 to 2009.

Second, although the austerity policy adopted in the 90's is held in check by the deepest economic and political crisis in Brazil's recent democratic history, [6] the government has stimulated household debt growth, without concerning to the level of human capital, profile of default or even employment status. Counterintuitively, household credit is reaching high levels even as loan interest rates are high; for the first time, household credit has exceeded firm credit. During the last decade the trajectories of household debt-to-cumulative income ratio, income commitment to pay loan rates and income commitment to amortization are very worrying.

Third, one can emphasize the disturbing evidence reported in Matos *et al*. (2015) about Brazilian household loan delinquency, which is driven by poverty and unemployment; and precisely in Northeast region, in states such as Alagoas and Rio Grande do Norte unemployment rats are systematically higher than 12%, while the percentage of the poor population remains higher than 25% in Maranhão and Alagoas for more than twenty years.

One can summarize Brazilian household credit market as heterogeneous, apparently inconsequential and driven by demand variables. In this scenario, we are convinced that it is

[6] For more details on the recent fiscal and monetary policies in Brazil, see Afonso, Araújo and Fajardo (2016).

worthwhile to broaden this discussion by modeling household credit solvency. More specifically we are aligned with Elekdag and Wu (2013) and Hansen and Sulla (2013), aiming to evidence if Brazil's recent economic conditions are consistent with sustainable financial development. In other words: should we be worried about a possible Brazilian household credit bubble? Otherwise, this recent excessive credit growth and its cycles are due to patterns of bank funding sources and to improvement of demand fundamentals.

Methodologically, building on Bohn's (2007) fiscal reaction function, we propose for the first time an approach which enables us to infer about the solvency of Brazilian household credit disaggregated by source of financial resources: non-earmarked, earmarked and total. This framework has been widely used in the empirical literature of public finance in Brazil, such as Matos, Simonassi and Pinto (2013), for instance. We provide an empirical exercise from April 2011 to August 2017 based on our innovative extended version which enables us to measure the causality from debt-to-GDP to surplus between amortization and granting of credit as a proportion of GDP, besides the role played by relevant credit risk proxies: the percentage of credit portfolio with arrears, the delinquency rate and the average term of new operations.

This letter is structured as follows. In the next section, we discuss about Brazilian credit market conjuncture, while in the third section we describe our methodology and report the empirical exercise results. Final considerations are presented in the fourth section.

3.2 Brazilian Credit Market

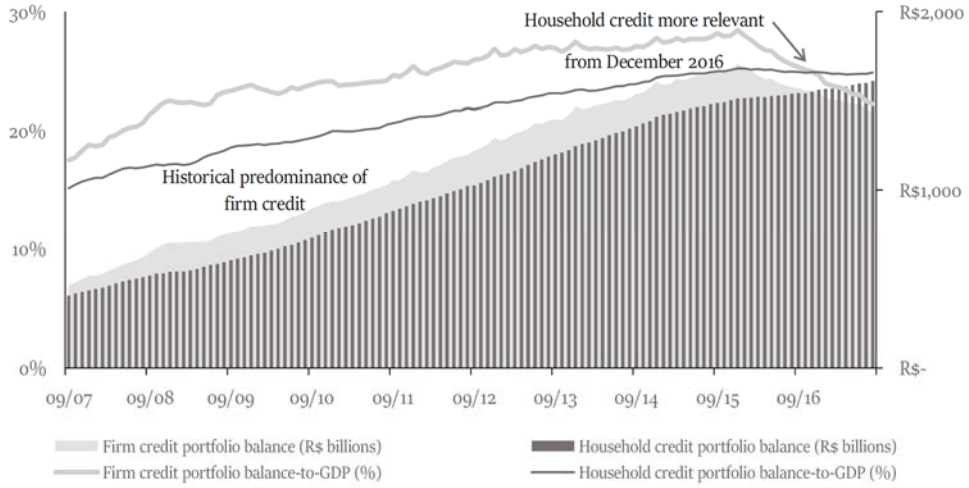
According to the World Bank dataset, the growth rate of Brazilian credit-to-GDP ratio from 2004 to 2011 was 11.4%, one of the highest rates worldwide. The average percentage of credit-to-GDP in Brazil during this period was approximately 39%, the third ranked value in a sample comprised by Latin American economies.

Separating Brazilian credit market into households and firms, we are able to show the predominant role of new operations in the productive sector during the period from September 2007 to November 2016. Firm credit share reached its highest value in December 2008, equivalent to 56.57% of the total credit balance in Brazil, while in December 2015 firm credit-to-GDP rose to 28.45%. However, accounting for historical time series, only recently, in December 2016, household credit has played for the first time, the most important role in the Brazilian financial system. According to the database of the Central Bank of Brazil (CBB), in August 2017, household credit reached 52.85% of the total credit balance in the country, which corresponds to 25% of GDP. Over the whole last decade, household credit has grown at an

average monthly rate of 1.17%, while firm credit has grown at a monthly rate of 0.95%.

Most strikingly, while firm credit has displayed a strong downward trend in 2016, with an average rate of -0.86% per month, household credit has continued to grow, even after November 2016, a politically turbulent period in Brazil. Household credit grew even during the subprime crisis in 2007 and 2008, according to Figure 1.

Figure 1 – Evolution of firm and household credit in Brazil during the last decade



Source: Central Bank of Brazil.

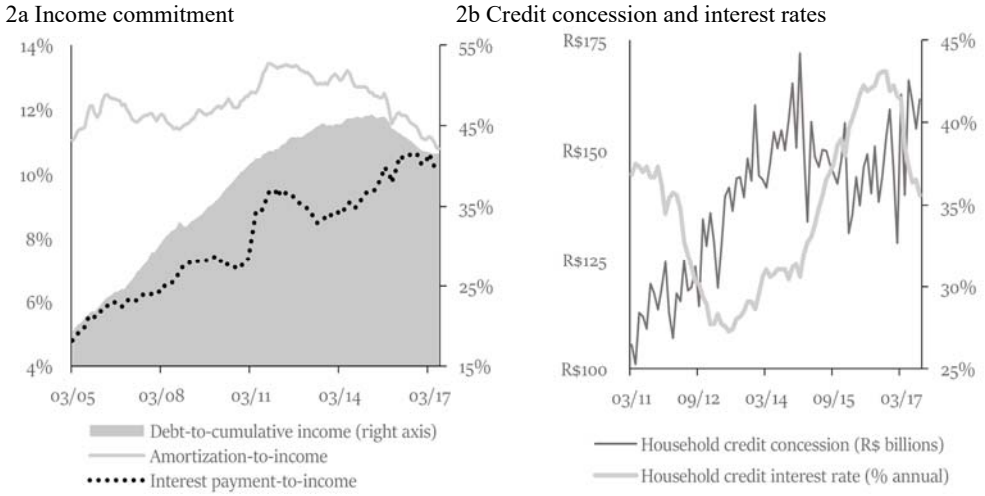
Regardless of the benefits due to firm or household credit, we need to better understand the drivers of Brazilian households, its role in the financial market and if its evolution is (or not) worrying. Figure 2 is useful for this last purpose.

According to Figure 2a, household amortization-to-income ranges from 10.5% to 13.5% during the period from March 2005 to July 2017, displaying a downward trend from mid-2014, a path that should not raise concerns. However, we can evidence a robust growth of the income commitment that accounts for loan interest rates. The difference between amortization-to-income and interest payment-to-income, which was already higher than 6% at the beginning of the sample period, is lower than 0.8% at the end of the sample period. It is still very troublesome the growth of debt-to-cumulative income, rising from almost 20% in March 2005 to more than 46% in April 2015. In the last two years, this ratio has dropped and is currently 41.6%.

Figure 2b shows that while household credit concession has grown until June 2013 in an environment characterized by a strong reduction in loan rates, during the last four years, household credit has risen, with more volatility and along with growth in loan rate. This concession has risen from R$ 136 billion in June 2013 to R$ 159 in December 2016, due to excessive demand, while loan rates have increased from 27.4% to 41.9% during the same

period.

Figure 2 – Brazilian household credit



Source*:* Central Bank of Brazil.

3.3 Empirical exercise

Our exercise adds to the findings on Brazilian household credit. In principle, the applied research studying credit and economic variables in developing economies has to address the trade-off between T and N. For the Brazilian economy, our first main limitation concerns the time series, since most of the credit variables are only available from March 2011.

We propose and estimate here an extended version of fiscal reaction, most recently described in Bohn (2007), which enables us to model household credit solvency taking into account for different financing sources: non-earmarked, earmarked and total resources. This is one of the most commonly used approaches to model the sustainability of government debts, based on budgetary intertemporal constraint and the impossibility of infinite debt rollover.

We are able to propose an adaptation of the model originally designed for government debt, which incorporates *i)* household reaction in terms of surplus between amortization-to-GDP and concession-to-GDP in time t due to changes of debt-to-GDP in time $t-1$, ii) the respective cycles and iii) the impact of proxies of credit risk measured by the percentage of credit portfolio in arrears, delinquency and average term of new operations. This framework is given by:

$$\frac{Amo_{i,t}}{GDP_{i,t}} - \frac{Con_{i,t}}{GDP_{i,t}} = \alpha + \varphi_I \frac{Int_{i,t-1}}{GDP_{i,t-1}} + \varphi_A \frac{\widetilde{Amo_{i,t}}}{GDP_{i,t}} + \varphi_C \frac{\widetilde{Con_{i,t}}}{GDP_{i,t}} + \varphi_P Arr_{i,t-1} + \varphi_D Deli_{,t-1} + \varphi_T Ter_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

In this model, $\frac{Amo_{i,t}}{GDP_{i,t}}$ is the amortization-to-GDP in time t for resource i, which can

be earmarked, non-earmarked or total. This notation is useful for estimating an equation for each household credit segment, whose difference is the resource. For the other terms, $\frac{Con_{i,t}}{GDP_{i,t}}$ is concession-to-GDP in time t for resource i, $\frac{Int_{i,t-1}}{GDP_{i,t-1}}$ is debt-to-GDP in time $t-1$ for resource i, while $\frac{\widetilde{Amo_{i,t}}}{GDP_{i,t}}$ and $\frac{\widetilde{Con_{i,t}}}{GDP_{i,t}}$ denote the respective cycles extracted from Hodrick-Prescot filter ($\delta = 14400$). This characterization corresponds to the default approach suggested in Bohn (2007).

We also estimate this version, but we report and make our main considerations based on the extended version, which incorporates the effects of the percentage of credit portfolio with arrears, $Arr_{i,t-1}$, delinquency rate, $Deli_{,t-1}$, and the average term of new operations, $Ter_{i,t-1}$, all in time $t-1$ for resource i.

As usual, we perform some preliminary testes about stationarity of our main variables, besides the cointegration test involving amortization-to-GDP and concession-to-GDP for each financing source. According to the results reported in Table 1, it seems that we do not care about spurious results in estimation. Our endogenous variables are stationary and then they do not cointegrate based on trace test.

Table 1 – Preliminary results (Period: from April 2011 to August 2017)

	Brazilian Household Credit		
Stationarity test [a]	Nonearmarked resources credit	Earmarked resources credit	Total credit
Amortization-to-GDP in *t*	-9.31343 ** [0.0000]	-4.61515 ** [0.0003]	-7.85953 ** [0.0000]
Concession-to-GDP in *t*	-6.18084 ** [0.0000]	-3.81226 ** [0.0042]	-5.26553 ** [0.0000]
Cointegration test [b]			
Amortization-to-GDP and Concession-to-GDP in *t*	0.15116 [0.0684]	0.12976 [0.2003]	0.14900 [0.1146]

Source: Author´s calculation.
Notes: a) Phillips & Perron (1988) test with intercept, whose null hypothesis is presence of unit root. b) Johansen (1991) trace test with intercept, whose null hypothesis is cointegration. Eigenvalue and respective p-value reported taking into account for none cointegration vector. P-values reported in brackets. * p-value < 0.05 ** p-value < 0.01

Our main results are reported in Table 2. The results suggest – as expected for this framework – that the difference between amortization and new concession reacts positively to contemporaneous amortization cycles and negatively to concession cycles. The most important results are associated with the parameter φ_I that measures the sensitivity of household reaction to the previous variation in the debt-to-GDP. In this case, the null hypothesis of the solvency of

the segment of credit is not rejected when this parameter is statistically non-zero and positive, indicating a household austerity reaction in time t, after an increase in the household debt in time $t-1$. This parameter is significant in all credit modalities, but the sustainability of household credit is rejected at 1% with both non-earmarked and total resources.

This evidence is corroborated based on the estimation of the same approach however taking into account for real credit variables, instead of their rations to GDP.

Table 2 – Household credit solvency (Period: from April 2011 to August 2017)

Estimation		Brazilian Household Credit		
Variable	Parameter	No-nearmarked credit	Earmarked credit	Total credit
Constant	α	0.01335 ** [0.0002]	-0.00299 ** [0.0010]	0.00595 [0.2217]
Debt-to-GDP in *t-1*	φ_I	**-0.00117 ** [0.0000]**	**0.00038 ** [0.0000]**	**-0.00092 ** [0.0004]**
Amortization-to-GDP cycles in *t*	φ_A	1.09723 ** [0.0000]	0.96321 ** [0.0000]	1.09055 ** [0.0000]
Concession-to-GDP cycles in *t*	φ_C	-1.11610 ** [0.0000]	-1.11974 ** [0.0000]	-1.10972 ** [0.0000]
Percentage of credit portfolio with arrears in *t-1*	φ_P	-8.88 e-5 [0.2674]	0.00035 ** [0.0000]	0.00108 ** [0.0000]
Delinquency rate in *t-1*	φ_D	0.00024 ** [0.0001]	0.00031 [0.2091]	-0.00036 [0.2571]
Average term of credit concession in *t-1*	φ_T	0.00012 ** [0.0001]	-1.71 e-5 ** [0.0001]	0.00010 ** [0.0000]
Complementary results				
Adjusted R^2		0.98283	0.95441	0.96368
Wald test (p-value) H_0: $\varphi_P=\varphi_D=\varphi_T=0$		24.4282 ** [0.0000]	54.1468 ** [0.0000]	116.6941 ** [0.0000]
Wald test (p-value) H_0: All parameters are null		716.4285 ** [0.0000]	262.7021 ** [0.0000]	332.6972 ** [0.0000]

Source: Author´s calculation.
Note: Difference between amortization-to-GDP and concession-to-GDP (both in *t*) as a dependent variable, according to equation (1). P-values reported in brackets. * p-value < 0.05 ** p-value < 0.01

When one pays attention to the composition of total credit, in terms of the new operations, non-earmarked credit ranges between 84% and 92% of the total household credit concessions. However, its influence in terms of total portfolio balance is lower and has a smooth downward trend, decreasing from 70% of the total credit concessions in April 2011 to 51% in August 2017. Since non-earmarked credit still has a larger share in total credit than earmarked

credit and has a greater elasticity (in absolute value), -0.00117 compared to 0.00038, which is three times larger, total household credit also seems to be explosive. The individual and joint significance of the credit risk proxies used in the extended fiscal reaction model highlight the longer-term effect of the new operations by stimulating both total credit and non-earmarked credit in the direction of household austerity. The delinquency rate seems to have a positive effect on austerity in terms of non-earmarked credit, while the portfolio with arrears is important only for total credit austerity.

3.4 Conclusions

Earmarked household credit in Brazil is mainly used for rural credit (1/3) and real estate financing (2/3), while non-earmarked credit is characterized by non-payroll loans, credit cards, overdraft, vehicles and other types of credit that are generally associated with the consumption of non-durable goods, semi-durable goods and services, which although relevant, are negligible and in many cases unnecessary. This type of credit, whose interest rates are on average six times higher than the interest rate charged on earmarked loans, has a higher delinquency rate and its credit cost index (measured by CBB) is five times the same index for earmarked credit. We claim here that this household credit should not be stimulated by the government as a means of increasing social welfare unless accompanied by an improvement in social, economic, labor market and human capital indicators. Otherwise, this might be the next bubble to be blown.

4 CREDIT SHORTAGES IN BRAZIL? A DISEQUILIBRIUM MODEL APPROACH

4.1 Introduction

Sound financial markets have long been recognized as essential to foster economic development, not only for mobilizing savings to finance investment and production, but also for their role in the efficient selection and monitoring of investment projects. In the case of Brazil, low access to affordable credit and inefficient financial intermediation have been identified as important barriers to sustained growth (HAUSMAN, RODRIK, and VELASCO, 2006).

While many studies focus in understanding the relative high costs of credit in Brazil, less attention has been paid to the analysis of potential gaps between quantities supplied and demanded of credit. This paper contributes to the literature by identifying and measuring shortage (excess of demand) episodes in the Brazilian credit market. Additionally, the paper investigates whether shortages arise or worsen during periods of economic crisis.

Perhaps the most basic principle of economics is that market equilibrium entails supply equaling demand. If demand should exceed supply, prices would rise, decreasing demand and/or increasing supply until demand and supply are equated. Nevertheless, credit shortages do occur and they have been vastly document in the literature (HURLIN and KIERZENKOWSKI 2007; NEHLS and SCHMIDT 2003).

Different theoretical underpinnings support the occurrence of credit shortages. Shortages may result from disequilibrium in credit markets. Temporary disequilibrium occurs when an economy is hit by exogenous shocks and there is some stickiness in the prices so that rationing occurs during the transition. On the other hand, long-term disequilibrium can be explained by governmental constraints such as usury laws.

Finally, credit shortages can arise as a part of the market equilibrium when information is asymmetrically distributed between lenders and borrowers. As pointed out by Stiglitz and Weiss (1981), the interest rates a bank charges may itself affect the riskiness of the pool of loans. This effect occurs through adverse selection – safer projects, that offer lower expect returns, are not profitable when interest rates are high – or through changes in incentives – when interest rise borrowers prefer to invest in riskier projects. In this context, when banks cannot fully assess borrower's risk, the profit maximizing loan rate can be below market clearing levels.

The literature shows that, in addition to the use of collateral, mechanisms that help to screen across good and bad risks, such as the use of credit bureaus and the development of

credit scoring models, may help to mitigate asymmetric information, reducing rationing effects. In Brazil, however, credit bureaus are underdeveloped and credit scoring technologies are not in line with international practices. Due to the lack of effective debtor information, such as financial data, debt exposure, guarantees etc, banks frequently rely on self-gathered data to sort out risks. Instead of project risk/profitability, credit allocation tends to be based on imperfect indicators of firm risk such as age, size, property structure, and the existence of ongoing business relationships between firms and banks (KUMAR and FRANCISCO 2005).

Credit shortages can be sensitive to economic cycles and crisis episodes. As discussed, interest rate rigidities that prevent upward adjustments in the interest rate may intensify financing gaps during economic downturns. Downturns also affect the risk and the expected profitability of projects, worsening the rationing effects of asymmetric information.

This paper seeks to identify and measure shortages episodes and to understand the links between credit shortages and economic cycles. We apply a disequilibrium model to estimate the demand and supply of credit to Brazil. In this framework the observed volume of credit operations is equal to the minimum of the quantities demanded and supplied, which are assumed to be unobservable.

Since Fair and Jaffee (1972), a large body of literature has been devoted to the econometric problems associated with estimating demand and supply schedules in disequilibrium markets. In a seminal paper, Maddala and Nelson (1974) derived the general likelihood function and proposed the appropriate ML estimating procedures for the empirical analysis of disequilibrium models. Most of empirical literature on credit shortages and credit crunches[7] is based on aggregate data analysis and build on this framework. Results in the literature tend to vary with the country and period analyzed. For example, Pazarbasioglu (1996) finds no evidence of credit shortages in Finland. According to the author, the credit decline during 1991-1992 appeared to be mainly explained movements in demand while credit supply remained relatively stable. Following a similar approach, Lama (2000) reports evidence of a credit crunch in Peru during 1999 and the first half of year 2000. In this case, the observed fall in credit was the result of a significant drop in supply. Credit demand remained relatively stable in the period.

This paper also focuses on aggregate data analysis. However, we adopt two alternative empirical strategies to estimate the disequilibrium framework. First, we follow the literature estimate the model using ML methods. ML estimation has the advantage of being

relatively simple and well known in the literature. However, the method depends on the underlining assumption of stationary residuals. As this condition cannot be assured in some specifications of the model, we estimate the model also using a Bayesian estimation approach originally proposed by Bauwens and Lubrano (2006). This approach is computationally intensive, but it allows us to circumvent some of the shortcomings faced by the ML approach. These two methodologies lead to similar results for the aggregate credit analysis but differ significantly for specific market segments such as corporate credit and credit from public and private institutions. In the first two cases shortages are underestimated under the ML framework, while in the last case shortages are significantly larger under the ML framework.

Our results indicate that Brazil experienced an excess of demand in credit during most of the last decade. In addition, our findings suggest that credit shortages are relieved and not intensified in moment of crisis. While credit supply evolves smoothly during the period, the demand for credit fluctuates in sync with the economic activity so that credit shortages are procyclical. These findings confirm the idea that shortages are associated with structural factor, not cyclical ones.

In addition to the analysis of credit aggregates, we study the demand and supply dynamics for different segments of the credit market that are particularly relevant in the Brazilian context, including non-earmarked credit, credit to firm, credit to individuals, credit from public institutions, and credit from private banks. Aggregate shortages seem to be mainly driven by shortages in non-earmarked credit. The aggregate dynamics is also closely related to the corporate segment. Shortages in personal credit and on credit from private banks are small and mainly concentrated in the middle of the decade. The Bayesian analysis shows that credit from public banks presents a large gap between supply and demand during most of the relevant period, but this gap decreased significantly towards the end of the decade.

The reminder of the paper is organized as follows. Section II presents the disequilibrium framework and the specifications used to estimate credit demand and credit supply. In section III, we describe the data and the estimation strategies. Finally, section IV discusses the empirical results and section V concludes the analysis.

4.2 The Disequilibrium Model

Fair and Jaffee (1972) generated a large body of literature focused on the econometric problems associated with estimating demand and supply schedules in disequilibrium markets. In line with this body of work, we use the disequilibrium model to estimate a credit demand function and a credit supply function simultaneously so that the

minimum of the two ("shortest side") determines the actual credit observed. The use of ML method to estimate disequilibrium models was first proposed by Maddala and Nelson (1974) in their seminal paper and has since been exploited in several studies testing the empirical significance of credit shortages (see, for example, Pazarbasioglu, 1996; Nehls and Schmidt, 2002; Baek, 2002; Hurlin and Kierzenkowski, 2007, Oulidi and Allain, 2009).

The general form of a disequilibrium model includes a system of equations relating credit demand and supply and a "short-side rule" function.

$$D_t = X_{1t}\beta_1 + \varepsilon_{1t}, \text{ Unobservable credit demand} \quad (1)$$

$$S_t = X_{2t}\beta_2 + \varepsilon_{2t}, \text{ Unobservable credit supply} \quad (2)$$

$$C_t = \min(D_t, S_t), \text{ Short-side rule Function} \quad (3)$$

Where D_t denotes the quantity of credit demanded, S_t denotes the quantity of credit supplied and C_t is the actual credit observed in the market. X_{1t} and X_{2t} are the explanatory variables affecting credit demand and supply respectively, β_1 and β_2 are parameters. Assuming that the error terms ε_{1t} and ε_{2t} are independently and normally distributed (with variances σ_1 and σ_2, respectively), the two conditional probability density functions (pdf) of credit are

$$g(C|C = D < S) = \int_C^{\infty} g(C, S)dS \quad \text{and} \quad g(C|C = S < D) = \int_C^{\infty} g(C, S)dS \quad (4)$$

Following Maddala (1987), the unconditional pdf of credit can be written as:

$$h(C) = \int_C^{\infty} g(C, S)dS + \int_C^{\infty} g(C, D)dD\, dD \quad (6)$$

The log-likelihood function is:

$$L = \sum_{t=1}^{n} \log h(C_t) \quad (7)$$

We can also compute the probability of the observed credit C_t to be on the demand or on the supply regime.

$$\pi_t^d = \Pr(C_t = D_t < S_t) = \Phi\left(\frac{X_2\beta_2 - X_1\beta_1}{\sqrt{\sigma_1^2 + \sigma_2^2}}\right) \quad (8)$$

Where Φ is the standard normal cumulative distribution function (cdf).

The log-likelihood (7) can be maximized using numerical methods. After the parameters are estimated, a second step is needed to associate a particular observation in time with the demand- or the supply-equation. To obtain an impression of which side of the market determined the actual market result (i.e. the volume of credit) one has to compare the estimated demand and supply. If in one period the estimated supply is smaller than the estimated demand, it is likely that the credit volume of this observation is supply-constrained. The probability that an observation is demand- or supply-constrained can be calculated according to equation (8).

Credit Demand Equation

For the demand function, we follow the specification as a benchmark case.

$$D_t = \beta_{11} + \beta_{12} r_{\text{lending},t} + \beta_{13} Y_t + \varepsilon_{1t} \quad (9)$$

Following a traditional theory of demand, the benchmark specification includes the nominal average lending rate as measure of loan prices and the GDP as measure of income. For the former we would expect a negative relationship with the credit demand, as falling cost of capital should be associated with a rise in demand. On the other hand, we expect credit demand to be positively correlated with the GDP, a proxy for the overall economic activity.

In addition to this parsimonious specification, other relationships are also tested. Alternative explanatory variables include current inflation, expected inflation and stock price index. The inflation rate is used here as a proxy for general macroeconomic condition and is negatively related to the demand for credit. Expected decline in inflation may also affect the credit demand by increasing the real cost of debt payments. This is the debt deflation phenomenon. Finally, the stock price index measures the availability and use of other financing sources by firms and it is expected to have a negative effect on banking credit.

Credit Supply Equation

Our specification of the supply function comes close to that of Pazarbasioglu (1996) and Nehls and Schmidt (2003) in many respects.

$$S_t = \beta_{21} + \beta_{22}\left(r_{\text{lending},t} - \text{Selic}_t\right) + \beta_{23}\text{Deposit}_t + \beta_{24} X_t + \varepsilon_{2t} \quad (10)$$

The term $(r_{\text{lending},t} - \text{Selic}_t)$ is the spread between the lending rate and the basic Selic rate. According to the explanation of Pazarbasioglu (1996), this term accounts for a cyclical risk premium. As described in Bernanke and Gertler (1990), this interest rate differential is in fact the external finance premium, which is negatively proportional to the level of indebtedness of borrowers. As the level of indebtedness grows, the agency costs associated with adverse selection and moral hazard increase, which contributes to a greater risk premium

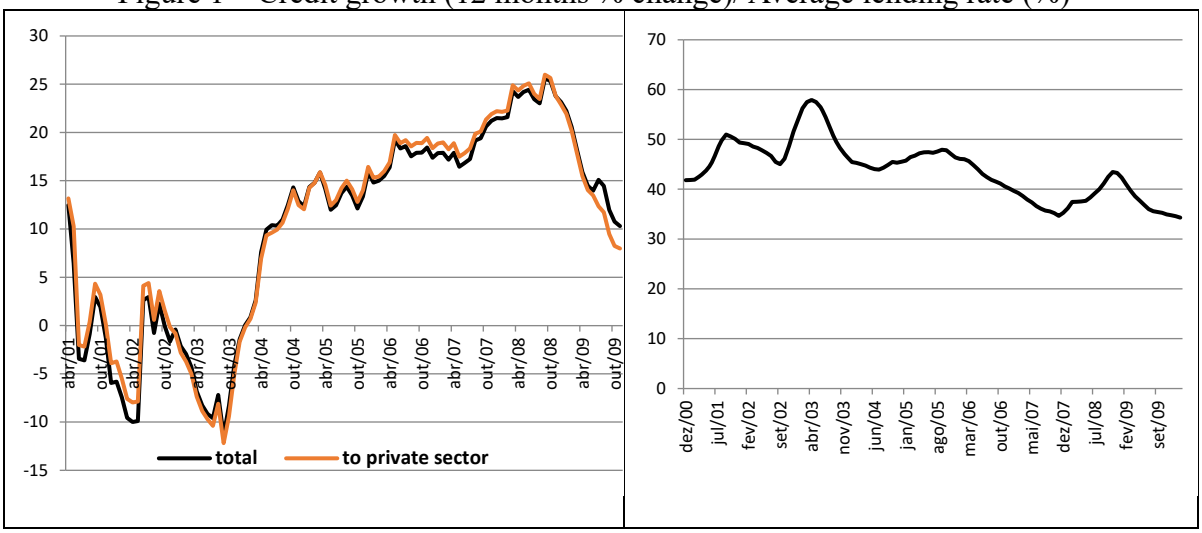
and a higher financing cost. The higher this interest rate spread, the lower is the expected quantity supplied of credit. The other standard explanatory variable, the time deposits, gauges the availability of loanable funds. The supply of credit is expected to be positively related to the amount of deposits banks receive. Other control variables considered in the analysis include expected GDP and expected inflation. The quantity of credit supplied is expected to increase with the level of economic activity, since projects are expected to be more profitable and less risky in a growing economic. The expected inflation rate is negatively related to the supply of credit as banks become more cautious in lending in a high-inflation regime. Unaccounted inflation is expected to reduce the real returns on credit.

4.3 Data and Estimation

Data

The analysis covers the sample period from June 2000 to April 2009, consisting of 107 monthly observations[8]. During this period, we identify three economic downturns defined here as at least a quarter of zero or negative GDP growth: the 2001 recession, the confidence crisis related to presidential elections in 2002, and the 2008 global financial crisis. During these periods, slowdowns in output were followed by lower credit and higher lending rate. (See Figure 1). The series were obtained from the Central Bank of Brazil, Ipeadata, and the Global Financial data. Please see Table A1 in Appendix A for the summary statistics and source of each series.

Figure 1 – Credit growth (12 months % change)/ Average lending rate (%)



Source: Central Bank of Brazil

We consider different segments of the credit market that are relevant in the Brazilian

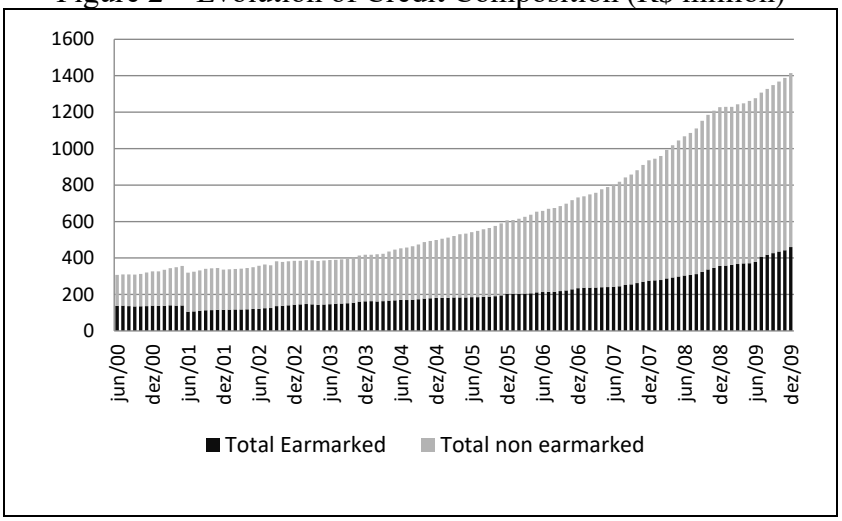
[8] With the exception of the analysis including market expectations of inflation which starts on November, 2001.

context. In addition to total banking credit, we estimated the model for non-earmarked credit, credits from public banks, credit from private banks, corporate credit and personal credit. The goal of this exercise is to identify differences in credit dynamics and potential financing constraints for each segment.

Earmarked versus Non-earmarked credit

The distinction between earmarked and non-earmarked credit is motivated by the evolution of the credit structure in Brazil. During the high inflation period, a large share of credit operations consisted of earmarked (directed) lending. These resources distributed not only by public financial institutions, but by private banks as well (mainly through public transfers and mandatory allocation of credit to housing and agriculture). Non-earmarked credit was scarce, short-term and relatively expensive.

Figure 2 – Evolution of Credit Composition (R$ million)



Source: Central Bank of Brazil

Since the macroeconomic stabilization, the Central Bank of Brazil has adopted several measures to promote the expansion of non-earmarked credit – including the expansion of credit products and modalities supervised by the Central Bank. Banking credit expansion in the last decade has been associated to the growth in non-earmarked credit. While non-earmarked credit represented less than a third of credit in the late 90's, currently it accounts for more than two thirds of total credit operations.

Earmarked and non-earmarked segments are significantly different. Earmarked credit is mainly financed with public resources. These resources are usually predetermined in the government's budget, but they can be extended if necessary (direct lending was expanded during the last financial crisis). Lending rates for earmarked credit also follow predetermined criteria and are much less sensitive to changes in credit market conditions. The non-earmarked

segment closely follows what is usually defined as private credit. Financing resources are originated from deposits and bonds, and lending rates fluctuates according to market dynamics. Non-earmarked credit can originate from private as well as public banks.

Private versus Public Credit Providers

Brazil has three large public banks BNDES[9], Caixa Econômica Federal, Banco do Brasil that account for approximately 40 percent of the total credit operations. The main objective of these institutions is to provide credit to market segments that are not well-served by private banks. They intend to address market failures and expand the spectrum of credit services available to firms and individuals. The private segment of the market, on the other hand is formed by five large financial conglomerate, and more than 120 smaller institutions that operate in specific segments of the market.

BNDES was originally created as a provider of long-term corporate credit. Currently, BNDES' activities also include credit lines to small and medium enterprises (SMEs) and local governments. BNDES is mainly financed through a variety of federal funds, including pension and social security funds, development funds, and export promotion funds.

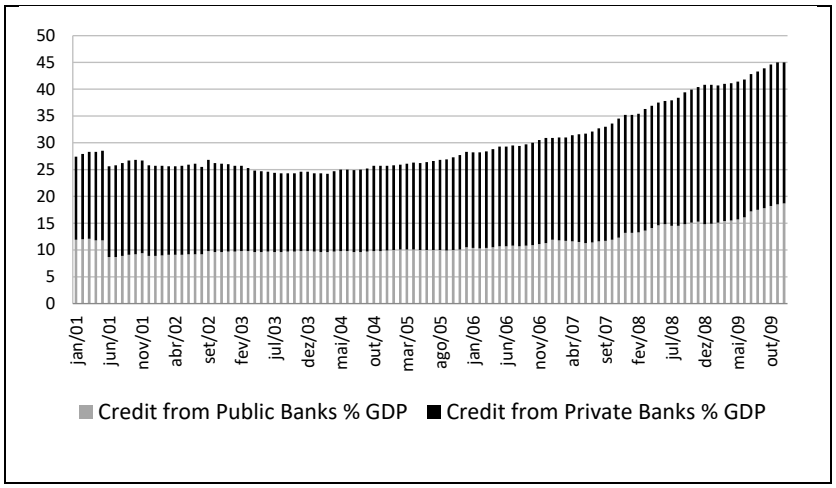
Created in 1852, Caixa Econômica Federal was the first public financing institution focused on savings from low-income households in Brazil. Currently, this institution is one of the main mortgage providers in the country. Loans are financed through savings and through the management of social security funds and the national lottery.

Banco do Brasil is a commercial bank with mixed ownership with the majority share held by the Brazilian government. This institution operates similarly to a large private bank, but it plays a special role in distributing earmarked credit resources to housing and agriculture activities.

While public banks dominated credit provision during the 1970s and 1980s, this segment has been losing relative importance since the beginning of the macro-stabilization period (Figure 3). This trend was inverted during the recent global financial crisis. During the last quarter of 2008 and most of 2009 the government implemented an aggressive expansion in credit from public banks as a way of preventing shortages in credit supply.

Figure 3 – Public versus Private Banks

[9] The Brazilian National Development Bank.



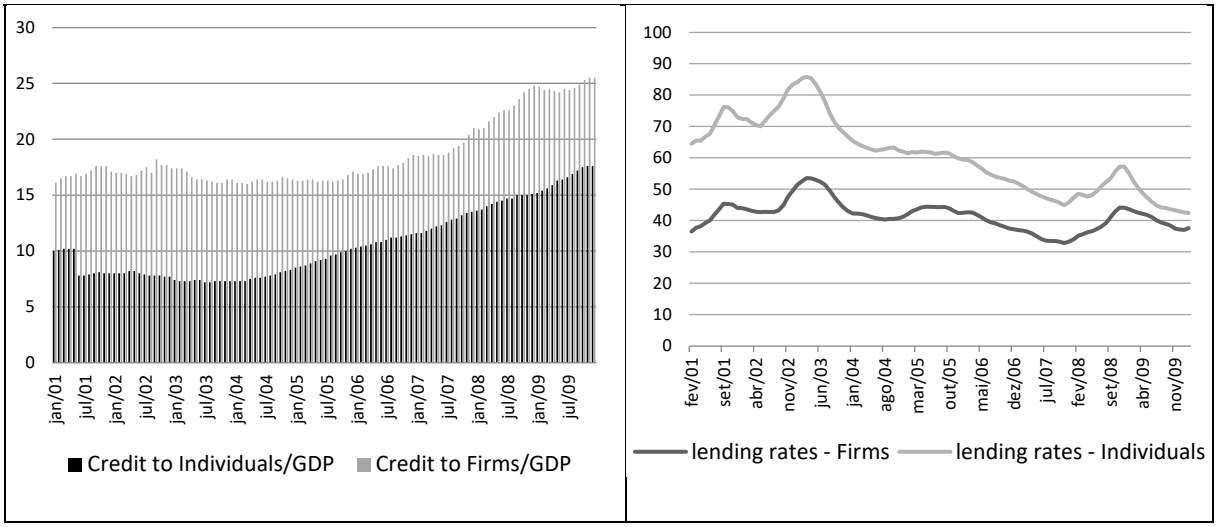
Source: Central Bank of Brazil

Firms versus Individuals

Firms use credit mainly to finance working capital and new investments. These variables are procyclical and they tend to fluctuate more than output. For this reason, one would expect credit demand by firms to vary with the level of economic activity. Individuals, on the other hand, use credit for consumption of durable and non-durable goods. Credit helps individuals smooth consumption over time and across economic cycles. As consumption tend to be less volatile that GDP, it is possible that individual credit is countercyclical or not cyclical at all. Another difference between the two segments is that firms tend to have a larger number of alternatives for financing expenditures. In addition to retained earnings, suppliers and banking credit, firms can finance activities through equity or bond markets. In contrast, individuals are restricted to saving and banking credit as formal financing options.

During the last decade Brazil experienced a significant expansion in credit. A large share of the expansion was driven by an increase in credit to individuals and a decrease in lending rates to this segment.

Figure 4 – Credit to Firms versus Credit to Individuals



Source: Central Bank of Brazil

Estimation Strategy

The first method adopted to estimate the model[10] is the ML estimation. As discussed above, this approach is frequently used in the disequilibrium literature. ML methods have the advantage of being intuitive, relatively well-known and standard in the literature. However, in order to perform well this method requires that the increments of the demand and of the supply equations, ε_{1t} and ε_{2t}, are stationary processes. If this assumption does not hold the log-likelihood function is asymptotically degenerated and the estimation can lead to spurious results. Thus, it is important to verify the stationarity of the series.

Table B1 is the Appendix B shows the results of the unit root tests. We can see that practically all variables are non-stationary. Hurlin and Kierzenkowski (2007) suggest that in this case one should use the stationary first difference of the variables to correct for the non-stationarity. However, this strategy would not be well suited in our case as the purpose of this study is to assess if the level of the supply is lower than the level of the demand, not the growth rate of them.

Alternatively, we follow Gosh and Gosh (1999). The authors argue that if the estimated supply and demand are co-integrated with the observed credit, then the residuals are stationary. Table B2 in the Appendix B brings the results of the Johansen co-integration test. It shows only the results for the specification (1) for each type of credit. We apply this test to all specifications. Since for all combination and modality of credit the co-integration hypothesis is not rejected, we proceed with the ML estimation of the model.

The log-likelihood function (7) is estimated using the Newton-Raphson iterative

[10] More specifically the parameters and variances described in section 2.

procedure. The estimation reveals that the likelihood is not always a "well-behaved" function of the parameters. In some cases, convergence was not achieved; in others the numerical method identified a local maximum. As the results are very sensitive to the initial conditions, this procedure cannot assure that the estimated parameters are global solutions. For this reason, we develop a second set of estimates based on a Bayesian approach suggested in Bauwens and Lubrano (2006).

The Bayesian approach uses the data augmentation principle to estimate the latent variables – credit demanded and credit supply of our disequilibrium model via Markov Chain Monte Carlo (MCMC) method. One advantage of this technique is that it provides the whole distribution of the parameters and latent variables (the posterior distribution). It is not subject to the numerical optimization problems of the MLE method. The Gibbs sampler algorithm proposed by Bauwens and Lubrano (2006) used to estimate our model is explained in detail in the Appendix B. For some credit market segments (public banks, private banks, and credit to individuals) this method leads to results that are significantly different from the ones obtained using ML estimation. These differences will be discussed in more detail in the next section.

4.4 Results

The results of the ML estimation for the benchmark specification are summarized in Table 1. Alternative specifications for the different credit segments are presented in Tables B3, B4, B5 and B6 in the Appendix B.

Credit Demand

As expected, in relation to the loan demand, the lending rate has the negative sign in all models and specifications. The impact of GDP on credit demand is also positive and significant in most models. The two exceptions are the demand for personal credit and credit from public banks. Possible explanations are that in the case of households and individuals, credit plays two important roles: the financing of investment (housing and durable goods) and smoothing consumption. While the first component tends to be procyclical, the second is countercyclical. These two effects seem to compensate each other. On the demand for credit from public banks, results are consistent with the firms and individuals seeing these institutions as an alternative source of credit in moments of crisis. Finally, in most cases and in particular in the case of corporations, credit goes down when the stock price index increases. This result is consistent with bank financing and equity financing being substitutes.

Credit Supply

In the loan supply, the risk premium – measured by the difference between the lending rate and the Selic and which represents agency cost, is negatively correlated with the supply of new credit. Although negative, the correlation between the risk premium and credit is not significant for the corporate and public banks segments. Time deposit gauges the availability of lending resources for banks and has a significantly positive effect on the supply of credit in all segments and specifications. One interesting result from the analysis is that the credit supplied by public institutions is positively correlated with the expected GDP and with the volume of credit supplied by private institutions. This result suggests that, on average, credit supplied by public institutions is procyclical and not countercyclical as initially expected. These finding will be further discussed when we present the estimated supply and demand paths.

Table 1 – ML Estimation for Credit Demand and Supply-Benchmark Specification

	Total Bank Credit	**Non-earmarked Bank Credit**	**Credit to Individual**	**Credit to Firms**	**Private Bank Credit**	**Public Bank Credit**
Demand Side						
Lending rate	-24.6***	-22.3***	-2.8***	-2.5***	-6.8***	0.8
	(4.77)	(0.89)	(0.22)	(0.78)	(1.55)	(0.61)
GDP	75.6***	67.2***	-0.0	3.1***	3.8***	-1.0***
	(8.44)	(4.14)	(0.07)	(0.16)	(0.25)	(0.21)
Expected Inflation	-21.9***	-8.6***	-2.1	57.9		-1.3
	(8.32)	(1.82)	(5.70)	(58.54)		(1.437)
Credit to Firms			0.76***			
			(0.02)			
Stock Price index				-76.1***		
				(20.9)		
Constant	2365.3***	1845.2***	184.7	656.2***	251.3*	118.2**
	(178.4)	(33.78)	(18.92)	(230.1)	(132.8)	(230.1)
Sigma1	8.8***	7.4***	3.3***	3.9***	12.0**	10.3***
	(2.48)	(1.95)	(0.52)	(1.09)	(4.73)	(1.08)
Supply side						
Risk premium	-10.6***	-9.6***	-0.8***	1.2	0.9*	-0.6
	(1.34)	(2.20)	(0.27)	(1.27)	(2.03)	(0.68)
Time Deposit	1.9***	1.5***	0.4***	0.8***	1.2***	0.5***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.04)
Expected GDP	-6.6	1.1	-0.4***	-0.3		0.6***
	(3.16)	(9.45)	(0.08)	(0.20)		(0.08)
Credit to Firms			0.9***			
			(0.03)			
Private Credit						0.1**
						(0.04)
Constant	665.6***	361.7***	-131.6**	-8.2	-404.3	0.9
	(90.60)	(103.18)	(42.05)	(177.03)	(269.76)	(28.51)
Sigma2	38.1***	37.8***	3.8***	19.2***	34.7***	3.8***
	(2.97)	(2.95)	(0.31)	(1.39)	(2.48)	(0.76)
Log Likelihood	-445.4	-442.6	-287.4	-453.5	-525.1	-298.8

Source: Author´s calculation.

Table 2 presents the average gap between credit supply and credit demand during the sample period and a few relevant sub-periods – including economic booms and crisis periods whereas the graphs in Table 3 highlight the estimated paths for quantities supplied and demanded in different credit segments. The results indicate that Brazil faced an excess of credit demand during most of the sample period. The average annual excess demand in credit was R$ 230 billion, almost 20 percent of the average quantity demanded in the period. The results from the ML estimation also suggest that credit shortages were significantly lower for individuals than for corporations and they were mainly driven by a lower supply of credit from private banks. In fact, there seems to be a small excess supply of public credit.

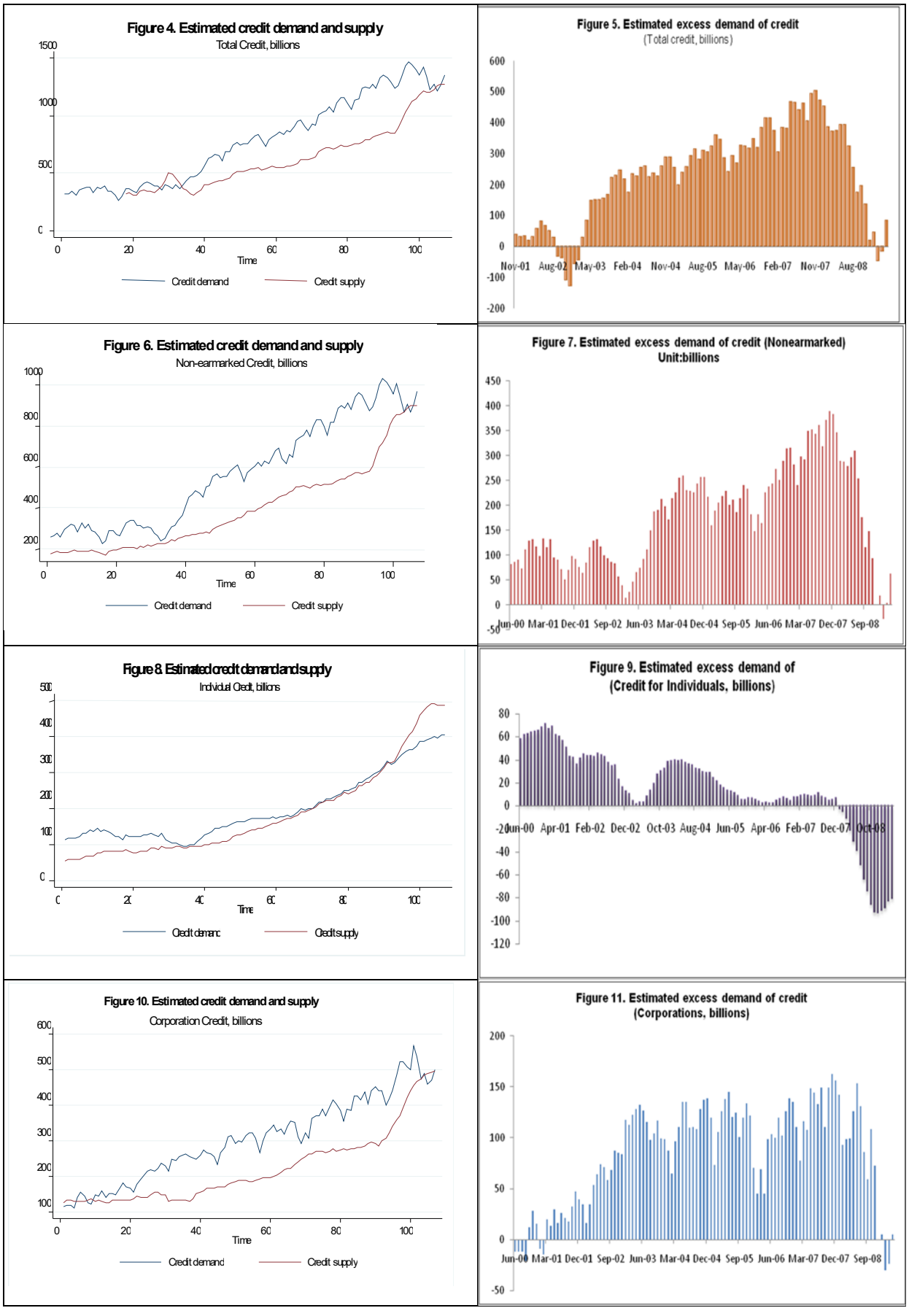
Table 2 – ML estimation – Average Annual Credit Shortage by Period (R$ billions)

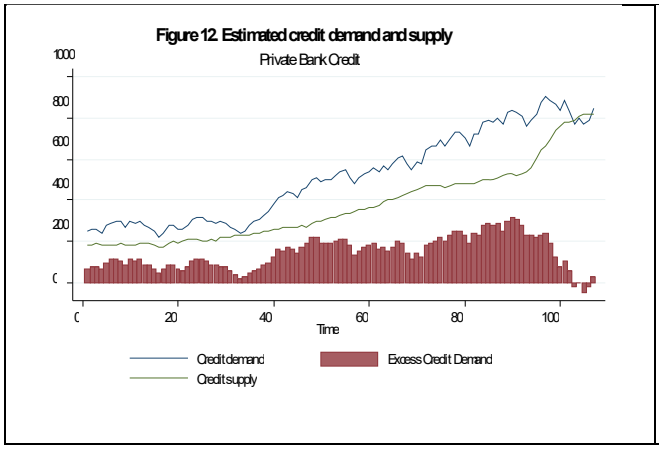
		Total Credit	Non-earmarked	Credit to Individuals	Credit to Firms	Private Bank	Public Bank
Periods							
Whole period	**A**	**230.1**	**177.7**	**14.3**	**83.7**	**365.9**	**-272.7**
	S						
	D	154.7	98.6	37.7	50.1	223.1	144.3
Before 2004	A	63.1	98.6	39.8	54.3	114.5	-113.4
	S						
	D	98.3	40.2	20.6	46.2	222.4	26.8
After 2004	A	297.9	230.8	-2.9	103.4	468.1	-337.5
	S						
	D	117.5	90.2	37.0	42.4	117.3	120.3
Crisis:							
US recession: 2001:Q1-2001:Q3	A	n.s	101.1	58.0	13.1	n.s	n.s
	S						
	D	n.s	25.7	10.2	14.5	n.s	n.s
Elections: 2002:Q3-2003:Q2	A	7.6	67.3	16.1	99.4	-61.0	-117.4
	S						
	D	87.7	29.9	13.0	25.3	215.6	11.1
Financial crisis: 2008:Q3-2009:Q2	A	118.1	85.3	-80.4	40.9	325.5	-548.1
	S						
	D	114.9	85.7	13.0	54.5	52.1	16.3
Boom:							
Complementary to Crisis	A	285.8	216.4	21.2	95.2	447.2	-259.7
	S						
	D	121.2	85.2	22.1	44.9	135.1	109.1

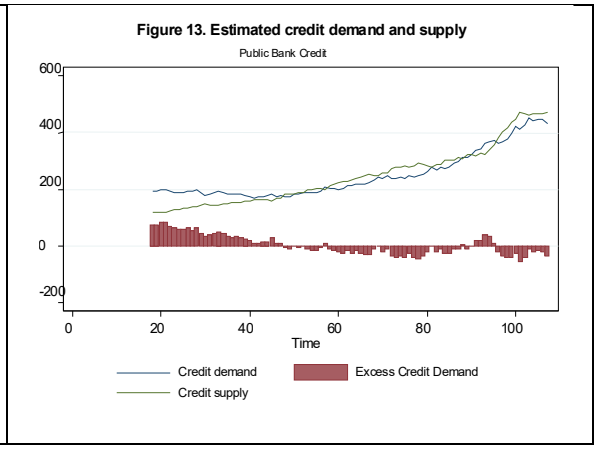
Source: Author´s calculation.
A: average; SD: standard deviation; Q1 means: first quarter

Although observed credit outcomes grew significantly in the second half of the decade, excess of demand seemed to have increased during this period. For almost all segments, credit shortage increased after 2004. The volume of credit supplied grew continuously for most of the period fostered by the stable macroeconomic conditions, the fiscal consolidation and favorable economic environment. However, expansions in the credit supply were not fast and large enough to meet the increase in the quantity of credit demanded by economic agents.

Table 3 – ML estimation Supply and Demand Path







Source: Author´s calculation.

As for the demand side, there were two exceptions to this pattern: credit to individuals and credit from private banks. The supply of credit to individuals closely followed demand until its boom in 2007/2008. This boom is possibly associated with regulatory changes and financial innovations that fostered the increase in observed credit and decrease in credit costs that were presented in Section 3. In the case of public banks, the results are consistent with the government's strategy of expanding credit both as a tool for reducing lending costs and as preventive measure against shortages during global financial crisis. The estimation indicates that there was a mild overshooting from the government side, as credit shortages became surplus around the crisis period. Another interesting point concerning the public and private segments is that the quantity demanded from private institutions decreased much more than the quantity demanded from public banks during the latest crisis. One explanation of this finding is that credit from private banks may have been partially crowded out by the government strategy.

Credit shortages are not positively associated with crisis episodes. The comparison of average excess demand during crisis episodes and expansion periods revels that credit conditions are significantly tighter during expansion period. Crisis seem to have only a minor effect in the supply path and most of the movements in credit markets seem to be driven by the sharp fall on credit demand. When the public credit is treated as the dependent variable, results indicate that the demand and supply of public credit are quite balanced, even during crisis episodes.

In conclusion, the overall results from the ML estimation support the hypothesis of structural shortage in the Brazilian credit market. While economic downturns are usually linked to a drop in observed credit outcomes, our ML estimation shows that, in the last decade, downturns affected credit demand more than credit supply. Our results indicate that economic slowdowns tend to alleviate credit shortages instead of intensifying them.

To address the shortcomings of the ML estimates and to verify the robustness of the previous findings, we repeat the benchmark exercise using a Bayesian (B) approach. Table 4 compares the coefficients estimated using the ML and B approaches. The detailed results from the Bayesian analysis are presented in Tables B7 and B8 in the Appendix B.

The results from the Bayesian estimation are generally consistent with those from the ML approach for total banking credit and non-earmarked credit. All coefficients have the same sign, but ML predictions are significantly more sensitive to changes in the lending rate, GDP, and risk premium. In the analysis of personal and corporate credit, the main differences between the two approaches refer to the relationship between GDP and credit demand and the role of the Stock Price index for corporate credit. In contrast with our previous findings, the Bayesian estimates suggest that the quantity of credit demanded by individuals is procyclical, while the quantity demanded by firms is not significantly sensitive to changes in GDP. This result could be explained by the effect of the stock price index. In the Bayesian estimation this coefficient is positive and it seems to capture changes in economic conditions rather than the relative cost between equity and bank financing. The analysis for private and public banks reveals two interesting differences between ML and B coefficients. First, the results from the Bayesian analysis indicate that the demand for credit from public banks is positive related to the average lending rates in the market. This result is intuitive since the rates offered by public institutions tend to fluctuate less than those offered by private banks, so that higher average rates are associated with better relative conditions for credit in public institutions. Second, controlling by the interest rate effects, the demand for credit from public banks is positively correlated with the GDP.

Table 4. Comparing ML and B estimations

	Method	Total Credit	Non-earmarked	Credit to Individuals	Credit to Firms	Private Bank	Public Bank
Demand							
Lending Rate	ML	-24.6***	-22.3***	-2.8***	-2.5***	-6.8***	0.8
	B	-8.2	-3.5***	-1.5***	1.19	-3.3***	5.3***
GDP	ML	75.6***	67.2***	0	3.1***	3.8***	-1.0***
	B	4.4***	3.9***	0.8***	0.18	3.6***	0.8***
Inflation	ML	-21.9***	-8.6***	-2.1	57.9		-1.3
	B	122.9		24.1			2.2
Credit to Firms	ML			0.8***			
	B			0.6***			
Stock Price index	ML				-76.1***		
	B				48.9***		
Supply							
Risk premium	ML	-10.6***	-9.6***	-0.8***	1.2	-0.9	-0.6
	B	-7.1	-5.1***	-3.7***	1.9	0.3	0.0
Time Deposit	ML	1.9***	1.5***	0.4***	0.8***	1.2***	0.5***
	B	2.1***	1.4***	0.3***	0.6***	1.5***	0.3***
GDP	ML	-6.6	1.1	-0.4***	-0.3		0.6***
	B				0.33		0.3**
Credit to Firms	ML			0.9***			
	B			0.5***			
Private bank Credit	ML						0.1**
	B						0.2**

Source: Author´s calculation.

ML = Maximum Likelihood estimation; B = Bayesian estimation, n.s. = non-significant

The Bayesian analysis confirms the existence of excess of demand for credit in Brazil during most of the last decade. In addition, the model suggests that credit shortages ease up during downturns. This effect can be detected by the changes in the probability of a demand regime (i.e. the probability that the quantity demanded is lower than the quantity supplied). While this probability increases modestly during the first crisis, it spikes up during the recent financial crisis. The same pattern occurs for total, non-earmarked and private credit. In the case of credit from public banks and corporate credit, the first two crises had a small but positive effect on demand, so the shortage increased slightly. In the recent crisis, however, probabilities of a demand regime increased according to the pattern previously described. Finally, shortages are never significant for personal credit, but this segment do experience a mild surplus during the financial crisis.

The findings from the Bayesian estimation are different from the ML results with respect to the magnitude of estimated shortages. These differences are particularly large for private banks, public banks and credit to firms. For the first segment, shortages predicted by

the Bayesian approach are significantly smaller and the surplus associated with the recent crisis is larger. On the other hand, credit shortages for corporate and public banks segments are much more pronounced than previously estimated. Demanded credit is almost five times larger than the amount supplied in the beginning of the decade. In both case, the credit gap narrowed down to less a fifth of total demand in the latest years driven by a continuous expansion in supply.

Finally, the analysis of public and private credit providers leads to results that are very different from the ML estimates. According to the Bayesian estimation, credit shortage for private banks is significantly smaller than the one for public institutions. Here, the estimated effects of economic crisis in easing shortages were to be larger for private institution than for public ones. This difference can be explained by a relatively large drop in the demand for private credit and it is consistent with the crowding out effect previously discussed.

4.5 Conclusion

This paper uses a disequilibrium model to investigate the occurrence of credit shortages in Brazil. The model is estimated using both maximum likelihood and Bayesian approaches. In addition to total bank credit, the analysis is applied on different segments that are relevant to the functioning of the Brazilian credit markets such as non-earmarked credit, personal credit, corporate credit, credit from public banks and credit from private institutions.

Some aspects of the Brazilian banking system and its underlying institutional framework seem to favor the prevalence of asymmetric information problems. As shown by Stiglitz and Weiss (1981), in this context, credit rationing is a possible equilibrium outcome.

In fact, Brazil experienced excess-demand in credit during most of the past decade, but our results show a continuous reduction in credit shortage towards the end of the decade. Results also indicate that credit shortages are relieved and not intensified in moments of crisis. While the volume of credit supplied evolves smoothly following an upward trend, the quantity demanded tends to fluctuate with economic activity so that credit shortages behave procyclically. The predictions are consistent for the two estimation strategies.

Credit dynamics vary across market segments and credit providers. Gaps between the demand and supply for credit to individuals are small and they change from positive to negative along the sample period. There seems to be no clear pattern between credit to individuals and economic cycles. In the corporate segment, shortages are more severe and they seem countercyclical, especially in the second part of the last decade. Shortages in credit from private institutions also tend to behave countercyclically. However, our results do not indicate a clear pattern between excess of demand for public institutions and the level of economic

activity.

During the global financial crisis, the government adopted the strategy of expanding lending from public institutions as a way of prevent liquidity shortages and a supply driven contraction in credit. Our results indicate the volume credit supplied by private institutions remained fairly stable during the crisis period. The drop in observed credit outcomes in this segment were mainly driven by a significant drop in credit demand. On the other hand, demand for public credit remained fairly stable, and the increase in credit supplied produced a surplus in this segment. Although not conclusive, this evidence is consistent with the idea of partial crowding out of private credit by public institutions.

Finally, one of the contributions of the paper is to estimate the credit disequilibrium across market segment using the standard ML estimation but also a Bayesian estimation approach. Our ML estimation indicates that the average excess of demand is larger among private institutions while the Bayesian approach shows much larger gaps among public institutions. In this case, the Bayesian results are in line with the fact that credit provided by public institutions tends to be cheaper and offer better term conditions. In addition, lending rates in this segment are settled according to pre-determined criteria and are less sensitive to changes in market conditions.

Although the paper does not aim to identify the exact forces behind credit shortages in Brazil, we show that, in the last decade, credit shortages were not associated with cyclical drops in supply. Our results are consistent with the existence of structural shortages in the Brazilian credit market.

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APPENDIX A

Table A1 – Credit from BNDES to total revenue from 2009 to 2013, except for Federal District

State	Credit from BNDES to total revenue					
	2009	2010	2011	2012	2013	2014
Acre	13.52%	1.42%	16.26%	8.38%	0.24%	4.45%
Amapá	5.60%	7.94%	0.00%	0.00%	18.49%	7.06%
Maranhão	3.97%	5.33%	0.00%	0.00%	19.98%	6.97%
Piauí	18.56%	4.60%	0.00%	6.99%	0.00%	0.93%
Espírito Santo	2.17%	2.31%	0.00%	19.23%	0.00%	5.21%
Paraíba	3.64%	5.36%	0.00%	6.78%	8.24%	7.12%
Santa Catarina	0.61%	0.61%	0.25%	2.94%	15.39%	7.94%
Mato Grosso	4.14%	6.30%	0.00%	9.89%	0.00%	8.12%
Sergipe	8.91%	5.20%	6.87%	0.00%	2.15%	1.79%
Ceará	4.67%	7.03%	0.00%	1.59%	3.70%	6.02%
Pernambuco	4.72%	3.76%	2.08%	3.40%	1.69%	4.71%
Mato Grosso do Sul	0.18%	1.11%	0.00%	3.83%	6.73%	4.75%
Goiás	0.00%	2.12%	0.00%	8.41%	1.51%	9.36%
Pará	4.05%	4.17%	0.06%	5.20%	0.10%	2.74%
Rio de Janeiro	0.79%	0.02%	0.72%	0.26%	4.46%	9.44%
Tocantins	4.09%	7.06%	0.00%	0.98%	0.30%	3.93%
Bahia	0.96%	4.68%	0.00%	0.00%	4.25%	1.31%
Roraima	5.03%	6.77%	0.00%	0.00%	0.00%	1.39%
Rio Grande do Norte	2.80%	3.74%	0.00%	0.00%	2.67%	0.16%
Amazonas	3.30%	6.27%	0.00%	0.75%	0.04%	2.80%
Rondônia	0.00%	3.31%	1.48%	1.88%	0.00%	0.93%
Alagoas	5.28%	0.03%	0.00%	0.20%	1.23%	2.34%
São Paulo	0.22%	0.61%	0.00%	1.94%	0.73%	2.23%
Minas Gerais	0.46%	0.67%	0.00%	3.05%	0.00%	0.52%
Rio Grande do Sul	0.00%	0.05%	0.79%	2.91%	0.08%	1.81%
Paraná	0.00%	0.00%	0.00%	0.47%	0.00%	1.91%

Source: STN and BNDES.

Table A2 – Fiscal Rating Index from 2009 to 2013, except for Federal District

State	Fiscal Rating Index				
	2009	2010	2011	2012	2013
Tocantins	A	A	A-	A-	A-
Amapá	A	A-	A-	B+	A-
Espírito Santo	A	A	B+	B+	B+
Roraima	A-	A-	A-	A-	B+
Amazonas	A-	B+	B+	B+	B+
Rondônia	A-	B+	B+	B+	B+
Pará	A-	B+	B	B	B+
Ceará	B	B	B+	B+	B+
Acre	A-	B+	B	B-	C+
Paraíba	B	B+	B-	B	B-
Rio Grande do Norte	B+	B	B	B-	B-
Pernambuco	B	B-	B-	B-	B-
Piauí	B-	B-	B-	B-	B-
Sergipe	B	B-	C+	B-	C+
Santa Catarina	B-	B-	B-	B-	C
Paraná	C+	C+	C+	B-	C+
Bahia	C	C	C+	B-	B-
Maranhão	B-	C+	C	C+	C+
Mato Grosso	C+	C+	C+	C+	C+
Rio de Janeiro	C+	C+	C+	C+	C
Mato Grosso do Sul	C+	C	C	C	C
Minas Gerais	C+	C	C	C	C-
São Paulo	C	C	C	C	C
Goiás	C	C	C-	C-	C-
Alagoas	C-	D+	D+	C-	C-
Rio Grande do Sul	D	D+	D+	D+	C-

Source: Manoel, Ranciaro Neto and Monteiro Neto (2016).

Table A3 – Technical efficiency from 2009 to 2013, except for Federal District

State	Technical efficiency				
	2009	2010	2011	2012	2013
Bahia	100.00%	100.00%	100.00%	100.00%	100.00%
Ceará	100.00%	100.00%	100.00%	100.00%	100.00%
Maranhão	100.00%	100.00%	100.00%	100.00%	100.00%
Minas Gerais	100.00%	100.00%	100.00%	100.00%	100.00%
Rio de janeiro	100.00%	100.00%	100.00%	100.00%	100.00%
São Paulo	100.00%	100.00%	100.00%	100.00%	100.00%
Pará	100.00%	100.00%	100.00%	100.00%	100.00%
Paraná	100.00%	100.00%	100.00%	100.00%	100.00%
Rio Grande do Sul	100.00%	100.00%	100.00%	96.80%	100.00%
Goiás	100.00%	100.00%	100.00%	100.00%	93.10%
Santa Catarina	97.70%	96.00%	100.00%	100.00%	97.30%
Paraíba	91.20%	100.00%	96.80%	100.00%	100.00%
Alagoas	82.90%	100.00%	100.00%	100.00%	100.00%
Piauí	89.80%	90.30%	100.00%	100.00%	100.00%
Roraima	96.00%	78.30%	98.70%	99.90%	100.00%
Amapá	100.00%	96.60%	86.70%	80.20%	100.00%
Rio Grande do Norte	95.50%	78.20%	97.40%	100.00%	90.00%
Pernambuco	87.10%	85.00%	94.10%	88.90%	99.10%
Acre	100.00%	100.00%	78.80%	67.10%	91.50%
Sergipe	100.00%	74.70%	77.40%	77.20%	90.40%
Mato Grosso do Sul	72.00%	73.80%	77.00%	100.00%	90.50%
Tocantins	100.00%	85.20%	72.00%	69.20%	82.80%
Mato Grosso	73.00%	76.50%	82.40%	72.10%	100.00%
Amazonas	75.40%	78.00%	81.40%	77.90%	76.70%
Rondônia	86.60%	69.50%	64.10%	64.70%	100.00%
Espírito Santo	67.80%	70.00%	69.20%	70.00%	78.70%

Source: Matos (2017b).

Table A4 – Real per capita GDP from 2009 to 2013, except for Federal District

State	Real per capita GDP				
	2009	2010	2011	2012	2013
São Paulo	R$35,242.80	R$38,402.42	R$38,698.09	R$37,890.76	R$41,149.25
Rio de Janeiro	R$29,729.31	R$32,338.20	R$34,222.77	R$35,006.19	R$40,394.53
Santa Catarina	R$28,534.32	R$30,994.54	R$31,914.41	R$31,295.61	R$33,844.32
Espírito Santo	R$25,751.66	R$29,674.01	R$32,846.19	R$33,802.30	R$31,973.55
Rio Grande do Sul	R$26,602.80	R$29,986.87	R$29,293.11	R$29,050.14	R$31,375.33
Mato Grosso	R$25,672.77	R$24,940.61	R$27,689.59	R$29,237.95	R$29,298.83
Paraná	R$23,913.53	R$26,423.32	R$27,155.02	R$27,264.69	R$31,869.74
Mato Grosso do Sul	R$20,722.41	R$22,567.06	R$23,703.05	R$24,503.30	R$27,961.53
Minas Gerais	R$19,272.08	R$22,772.90	R$23,342.71	R$22,903.41	R$24,936.39
Goiás	R$19,431.23	R$20,642.12	R$21,822.53	R$22,688.95	R$24,525.53
Amazonas	R$19,665.72	R$21,792.72	R$21,757.78	R$20,121.36	R$22,760.44
Rondônia	R$18,098.38	R$19,152.67	R$21,060.16	R$20,809.57	R$18,849.92
Roraima	R$17,849.31	R$17,876.93	R$18,014.95	R$17,553.59	R$19,177.77
Amapá	R$16,174.70	R$17,121.98	R$17,068.26	R$16,807.27	R$17,949.46
Tocantins	R$15,168.74	R$15,827.63	R$15,373.77	R$15,523.56	R$16,835.56
Sergipe	R$13,163.68	R$14,698.22	R$14,950.71	R$14,853.36	R$16,812.04
Acre	R$14,374.20	R$14,676.39	R$14,051.68	R$14,300.50	R$15,308.10
Pernambuco	R$11,973.31	R$13,743.77	R$14,043.93	R$14,805.52	R$16,104.20
Rio Grande do Norte	R$11,962.19	R$12,965.02	R$13,460.63	R$13,803.70	R$16,007.53
Bahia	R$12,712.91	R$14,464.14	R$13,025.18	R$13,333.65	R$14,345.60
Pará	R$10,570.85	R$13,042.26	R$13,707.19	R$13,110.94	R$15,885.31
Ceará	R$10,754.80	R$11,491.59	R$12,416.51	R$11,906.92	R$13,054.37
Paraíba	R$10,246.14	R$10,772.75	R$11,149.06	R$11,439.97	R$12,477.30
Alagoas	R$9,049.68	R$10,002.39	R$10,828.01	R$10,517.68	R$11,902.23
Maranhão	R$8,419.18	R$8,742.40	R$9,364.98	R$9,871.87	R$10,480.87
Piauí	R$8,139.34	R$8,985.03	R$9,344.76	R$9,170.02	R$10,393.19

Source: IBGE.

Table A5 – Gini coefficient from 2009 to 2013, except for Federal District

State	Gini coefficient				
	2009	2010	2011	2012	2013
Sergipe	0.5764	0.5630	0.5596	0.5418	0.5602
Maranhão	0.5383	0.5470	0.5415	0.6087	0.5602
Acre	0.6132	0.5500	0.5467	0.5504	0.5249
Bahia	0.5553	0.5510	0.5538	0.5480	0.5575
Rio Grande do Norte	0.5591	0.5520	0.5616	0.5313	0.5413
Paraíba	0.5914	0.5530	0.5378	0.5282	0.5253
Piauí	0.5548	0.5600	0.5075	0.5455	0.5154
Alagoas	0.5720	0.5570	0.5265	0.4994	0.5253
Ceará	0.5443	0.5560	0.5385	0.5268	0.5143
Rio de Janeiro	0.5423	0.5380	0.5330	0.5302	0.5322
Roraima	0.5213	0.5530	0.5242	0.5400	0.5308
Amazonas	0.5090	0.5570	0.5415	0.5110	0.5428
Pernambuco	0.5535	0.5590	0.5272	0.5074	0.5023
Amapá	0.5192	0.5470	0.5191	0.5371	0.5216
Tocantins	0.5233	0.5400	0.5227	0.5262	0.5193
Pará	0.5088	0.5390	0.5375	0.5013	0.5020
Espírito Santo	0.5316	0.5140	0.4975	0.4970	0.4940
Mato Grosso do Sul	0.5212	0.5130	0.5124	0.4879	0.4967
Mato Grosso	0.5044	0.4990	0.4791	0.5227	0.5046
Minas Gerais	0.5125	0.5080	0.4987	0.4993	0.4891
Rondônia	0.5093	0.5050	0.4959	0.4844	0.4760
São Paulo	0.4893	0.5040	0.4846	0.4929	0.4936
Goiás	0.5101	0.5050	0.4831	0.4805	0.4844
Rio Grande do Sul	0.4998	0.4900	0.4861	0.4765	0.4776
Paraná	0.4972	0.4880	0.4713	0.4834	0.4685
Santa Catarina	0.4597	0.4480	0.4437	0.4239	0.4350

Source: IPEA.

APPENDIX B

Table B1 – Unit Root Tests

Variables	Level			First difference	
	ADF test	**PP test**		**ADF test**	**PP test**
Total Credit	0.49	1.14		-5.47***	-5.62***
	[0.99]	[0.99]		[0.00]	[0.00]
Nonearmarked credit	-0.04	0.35		-3.17***	-4.18***
	[0.99]	[0.99]		[0.02]	[0.00]
Nonearmarked credit - Individuals	-1.29	-0.02		-1.63	-4.08***
	[0.88]	[0.99]		[0.46]	[0.00]
Nonearmarked credit - corporations	0.03	0.29		-4.14***	-6.51***
	[0.99]	[0.99]		[0.00]	[0.00]
Private credit	-0.39	-0.11		-3.33**	-4.79***
	[0.98]	[0.99]		[0.02]	[0.00]
Public Credit	0.61	0.64		-6.96***	-7.27***
	[0.99]	[0.99]		[0.00]	[0.00]
Lending rate	-2.13	-2.12		-7.43***	-7.71***
	[0.52]	[0.53]		[0.00]	[0.00]
GDP	-2.82	-4.39***		-3.96***	-16.09***
	[0.19]	[0.00]		[0.00]	[0.00]
Expected GDP	-2.44	-2.23		-6.76***	-6.83***
	[0.13]	[0.19]		[0.00]	[0.00]
Inflation inter	-2.51	-2.48		-8.57***	-8.58***
	[0.12]	[0.12]		[0.00]	[0.00]
Expected Inflation inter	-2.64*	-2.29		-7.39***	-7.32***
	[0.09]	[0.17]		[0.00]	[0.00]
Log Stock price	-2.13	-2.33		-8.66***	-8.65***
	[0.52]	[0.41]		[0.00]	[0.00]
Time deposit	-1.99	-0.19		-3.05**	-4.54***
	[0.59]	[0.99]		[0.03]	[0.00]

OBS: On the levels always used trend + constant. On the first difference only a constant
p-value in brackets. ***(**) means rejection at 1%(5%)

Table B2 – Cointegration Test

Variables : Total Credit and Demand			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	16.96	15.41	20.04
At most 1	9.16E-02	3.76	6.65
Variables : Total Credit and Supply			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero***	20.31	15.41	20.04
At most 1**	4.46	3.76	6.65
Variables : Nonearmarked Credit and Demand			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	16.79	15.41	20.04
At most 1	1.51	3.76	6.65
Variables : Nonearmarked Credit and Supply			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero***	16.94	12.53	16.31
At most 1	2.87	3.84	6.51
Variables : Credit for Individuals and Demand			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	18.67	18.17	23.46
At most 1	2.11	3.74	6.40
Variables : Credit for Individuals and Supply			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	20.95	19.96	24.60
At most 1	7.58	9.24	12.97
Variables : Credit to firms and Demand			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	17.62	15.41	20.04
At most 1	0.97	3.76	6.65
Variables : Credit to Firms and Supply			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	21.78	19.96	24.60
At most 1	2.66	9.24	12.97
Variables : Private credit and Demand			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero***	22.84	15.41	20.04
At most 1	0.05	3.76	6.65
Variables : Private credit and Supply			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	17.61	15.41	20.04

At most 1	0.73	3.76	6.65
Variables : Public credit and Demand			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero**	15.98	15.41	20.04
At most 1	1.96	3.76	6.65
Variables : Public credit and Supply			
H0: Number of Cointegration vectors	Trace Statistic	5% critical value	1% critical value
Zero***	33.35	19.96	24.60
At most 1	6.36	9.24	12.97

***(**) means rejection at 1%(5%)

Note: Only the Trace statistic is showed. For all combination and modality of credit, the co-integration hypothesis is not rejected.

Bayesian estimation strategy

Bauweans and Lubrano (2006) describe the Gibbs sampler algorithm. Consider $\theta = (\beta_1, \beta_2, \sigma_1^2, \sigma_2^2)$ the vector of parameter. The probability of the observed credit C_t to be in the demand regime, $C_t = D_t$, is given by (8). Given a draw θ^j, we evaluate (8) for each observation **t** and draw a uniform random number ν. Two vectors of dimension T (time series size) are constructed, y_d and y_s which contain alternatively observations and simulations of the demand and supply. We allocate C_t to the demand vector y_d if $\pi_t^d > \nu$ and generate S_t as a truncated normal

$$S_t \sim TN_{S_t > D_t}(X_2\beta_2^j, \sigma_2^{2j}) \qquad (11)$$

which is then allocated to the supply vector y_s. If $\pi_t^d < \nu$, we allocate C_t to the supply vector and generate D_t for the demand regime as

$$D_t \sim TN_{D_t > S_t}(X_1\beta_1^j, \sigma_1^{2j}) \qquad (12)$$

Given y_d and y_s, it's then straightforward to find the conditional posterior of $\theta = (\beta_1, \beta_2, \sigma_1^2, \sigma_2^2)$ to perform the Gibbs sampler. We are assuming that the error terms ε_{1t} and ε_{2t} are normally distributed, so picking a normal distribution as prior for β_1 and β_2 and an Inverse Gamma distribution for σ_1^2 and σ_2^2 will result in normals and inverse gammas posteriors.

Thus, the iteration j has the six steps below:

1. Set $\theta = \theta^{j-1}$;
2. Compute π_t^d using in (8) and draw a uniform random number ν;
3. If $\pi_t^d > \nu$, allocate $C_t$to y_d, draw S_t^j using (11) and allocate to y_s.
4. If $\pi_t^d < \nu$, allocate $C_t$to y_s, draw D_t^j using (12) and allocate to y_d.
5. Repeat the steps 2-4 for all observations;
6. Draw θ^j from its posterior distribution.

As previously mentioned, the result of the Bayesian estimation is the whole distribution of the parameters of the model. One can consider the Bayesian estimator of θ as the mean of the posterior distribution.

Table B3 – ML estimates for total credit demand and supply

	Specification (1)	Specification (2)	Specification (3)
Demand Side			
Lending rate	-9.058***	2.026	-24.629***
	(1.934)	(2.99)	(4.768)
GDP	6.165***	7.734***	
	(0.454)	(0.341)	
Expected GDP			75.623***
			(8.439)
Inflation	69.793***		
	(25.978)		
Expected Inflation		-12.931***	-21.91***
		(3.399)	(8.319)
Stock Price index	65.766		
	(44.912)		
Constant	-463.125	-562.515	2365.284***
	(459.121)	(202.540)	(178.398)
Sigma1	16.848***	13.679***	8.788***
	(4.169)	(3.966)	(2.478)
Supply side			
Risk premium	-9.657***		
	(1.901)		
Lending Rate		-8.642***	-10.638***
		(1.549)	(1.342)
Time Deposit	1.855***	1.812***	1.915***
	(0.049)	(0.052)	(0.053)
Expected GDP			-6.591
			(3.157)
Expected Inflation	20.36***	18.861***	16.159***
	(4.026)	(3.497)	(3.157)
Deposit rate Selic Spread	-12.296***		
	(2.137)		
Constant	623.742***	152.576	665.599***
	(56.626)	(287.2698)	(90.595)
Sigma2	38.346***	37.159***	38.144***
	(3.103)	(2.949)	(2.967)
Log Likelihood	-446.194	-445.375	-445.403

Table B4 – ML estimates for non-earmarked credit demand and supply

	Specification (1)	Specification (2)	Specification (3)
Demand Side			
Lending rate	-8.524***	-9.4390***	-22.326***
	(39.55)	(2.494)	(0.894)
GDP	4.36***	6.387***	
	(132.87)	(0.219)	

Expected GDP			67.228***
			(4.137)
Inflation		-48.3738*	
		(28.953)	
Expected Inflation			-8.628***
			(1.817)
Stock Price index		-208.474***	
		(44.4158)	
Constant	304.035***	2106.832***	1845.204***
	(16.99)	(530.798)	(33.789)
Sigma1	1.945***	7.748**	7.442***
	(2.66)	(2.232)	(1.952)
Supply side			
Risk premium	-2.361	2.213	-9.597***
	(2.093)	(2.379)	(2.205)
Time Deposit	1.395***	1.3705***	1.542***
	(0.0562)	(0.094)	(0.0514)
GDP		-0.229	
		(0.376)	
Expected GDP			1.113
			(9.447)
Expected Inflation			7.823**
			(2.518)
Deposit /Selic Spread		-6.606***	
		(1.732)	
Constant	-303.0194	-464.429	361.689***
	(274.27)	(331.248)	(103.182)
Sigma2	36.963***	35.432***	37.757***
	(2.581)	(2.605)	(2.953)
Log Likelihood	-529.2670	-517.9014	-442.6065

Table B5 – ML estimates for Public and Private Credit Demand and Supply

	Private Bank Credit	**Public** Bank Credit
Demand Side		
Lending rate	-6.75***	0.772
	(1.549)	(0.609)
GDP	3.754***	-0.985***
	(0.252)	(0.212)
Expected Inflation		-1.304
		(1.437)
Private Credit		
Constant	251.327*	118.209**
	(132.799)	(230.058)
Sigma1	12.043**	10.334***
	(4.728)	(1.078)
Supply side		
Risk premium	-0.997	-0.591
	(2.03)	(0.681)

Time Deposit	1.219***	0.514***
	(0.062)	(0.040)
Expected inflation	53.513**	0.047
	(20.742)	(0.362)
GDP		0.587***
		(0.079)
Private Credit		0.081**
		(0.039)
Constant	-404.309	0.887
	(269.757)	(28.506)
Sigma2	34.697***	3.849***
	(2.482)	(0.757)
Likelihood	-525.122	-298.819

Table B6 – ML estimates for individual and corporation credit

	Credit to **Individuals**		Credit to **Firms**	
	Specification (1)	Specification (2)	Specification (1)	Specification (2)
Demand Side				
Lending rate	-2.887***	-2.802***	-2.510***	-0.6279
	(0.19)	(0.2194)	(0.784)	(1.997)
GDP	-0.026	-0.0027	3.081***	3.667***
	(0.068)	(0.068)	(0.155)	(0.177)
Inflation		-2.076	57.908	-140.59***
		(5.702)	(58.540)	(38.612)
Credit to Firms	0.763***	0.7656***		
	(0.0177)	(0.0165)		
Stock Price index			-76.123***	-143.311***
			(20.884)	(28.168)
Constant	194.505***	184.719	656.239***	1244.777***
	(17.572)	(18.916)	(230.058)	(328.256)
Sigma1	3.344***	3.348***	3.924***	8.384***
	(0.552)	(0.5186)	(1.086)	(1.899)
Supply side				
Risk premium	-1.105***	-.7632***	1.204	-1.130
	(0.296)	(0.272)	(1.274)	(1.154)
Time Deposit	0.252***	0.416***	0.775***	0.858***
	(0.026)	(0.053)	(0.050)	(0.057)
GDP		-0.358***	-0.263	-0.565***
		(0.0766)	(0.203)	(0.199)
Credit to Firms	0.870***	0.87***		
	(0.0278)	(0.029)		
Inflation				100.086***
				(17.185)
Deposit rate/Selic			-4.133***	-7.726***
			(0.931)	(0.9847)
Constant	-81.287*	-131.623**	-8.182	220.971
	(45.789)	(42.05)	(177.03)	(155.331)

Sigma2	4.513*** (0.374)	3.812*** (0.314)	19.22*** (1.391)	16.308*** (1.206)
Log Likelihood	-303.867	-287.417	-453.510	-440.085

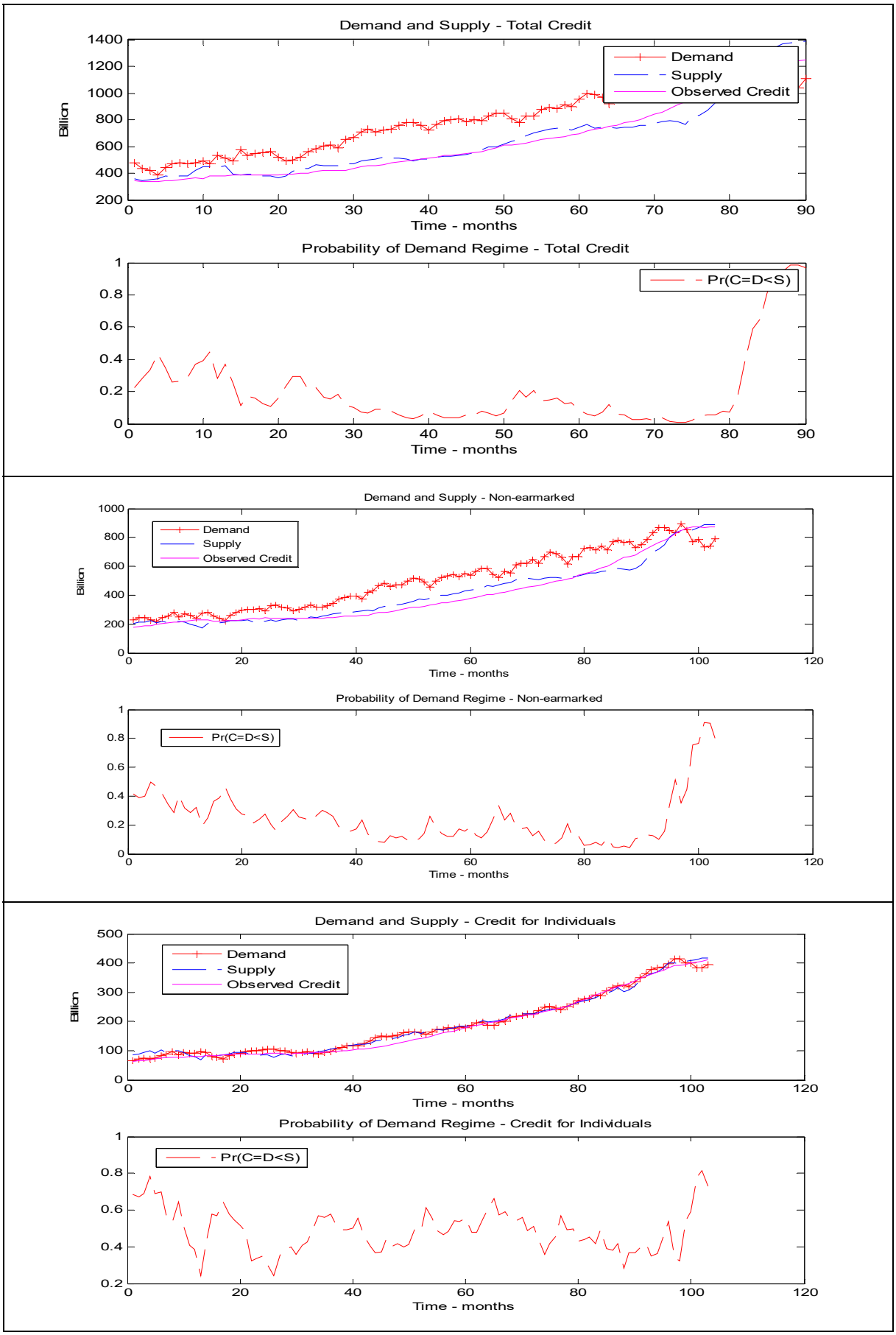
Source: Author´s calculation.

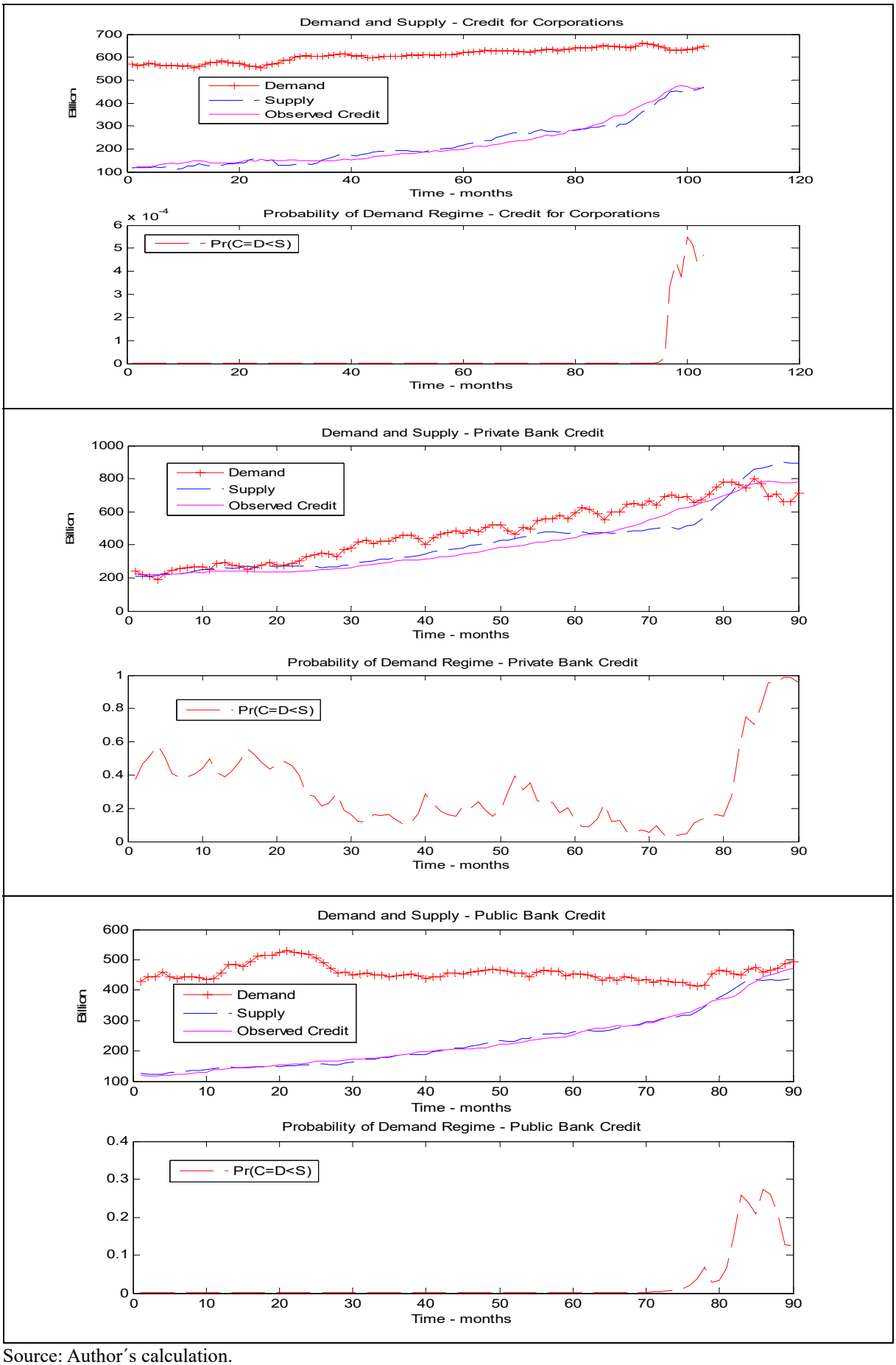
Table B7 – Bayesian estimation - Mean and Standard Deviation of the Posterior Distribution

	Total Credit	**Non-earmarked**	**to Individuals**	**to Firms**	**Private Bank**	**Public Bank**
Demand						
Lending Rate	-8.176	-3.458	-1.491	1.190	-3.251	5.320
	(34.897)	(1.017)	(0.237)	(2.470)	(0.812)	(1.628)
GDP	4.386	3.963	0.790	0.178	3.598	0.807
	(1.426)	(0.259)	(0.117)	(0.439)	(0.213)	(0.358)
Inflation	122.935			24.069		
	(171.844)			(99.008)		
Expected Inflation						2.209
						(6.630)
Credit to Firms			0.607			
			(0.060)			
Stock Price index	38.155			48.943		
	(36.287)			(18.461)		
Constant	-3.034	14.177	-0.838	1.705	9.196	5.968
	(60.158)	(45.468)	(12.988)	(21.947)	(40.128)	(20.174)
Sigma1	119.903	94.318	27.723	43.758	82.163	40.712
	(11.370)	(7.747)	(1.944)	(3.839)	(7.065)	(3.720)
Supply						
Risk premium	-7.105	-5.114	-3.731	1.909	0.263	0.019
	(7.738)	(1.304)	(0.545)	(1.057)	(1.219)	(0.479)
Time Deposit	2.130	1.355	0.277	0.584	1.503	0.328
	(0.118)	(0.074	(0.062)	(0.054)	(0.080)	(0.057)
GDP				0.333		0.346
				(0.189)		(0.120)
Credit to Firms			0.508			
			(0.079)			
Expected Inflation	3.126				-0.007	0.001
	(5.517)				(3.921)	(1.266)
Private bank Credit						0.217
						(0.045)
Constant	59.058	-3.796	-1.835	-0.033	36.700	0.178
	(46.184)	(33.109)	(13.348)	(15.768)	(33.223)	(12.327)
Sigma2	96.253	66.474	26.694	31.753	69.355	25.110
	(7.220)	(4.700)	(1.858)	(2.205)	(5.229)	(1.855)

Note: Standard Deviation in parenthesis. Estimation was base on 50,000 draws; the first 5,000 draws were discarded.

Table B8 – Bayesian estimation – Supply and Demand Path


Demand and Supply - Total Credit
Billion
Demand
Supply
Observed Credit
Time - months
Probability of Demand Regime - Total Credit
Pr(C=D<S)
Time - months
Demand and Supply - Non-earmarked
Billion
Demand
Supply
Observed Credit
Time - months
Probability of Demand Regime - Non-earmarked
Pr(C=D<S)
Time - months
Demand and Supply - Credit for Individuals
Billion
Demand
Supply
Observed Credit
Time - months
Probability of Demand Regime - Credit for Individuals
Pr(C=D<S)
Time - months



Source: Author´s calculation.