
Misallocation and TFP loss - a study of public bank loans in Brazil

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Misallocation is a well-studied topic among economists due to its potential effect on total factor productivity (TFP). In this paper I use a direct approach to study the contribution of public bank loans distortions to TFP loss in Brazil in 2014 through an adaptation of a monopolistic competition model. My results suggest that removing these distortions would represent around 23% of TFP gain in Brazil; moreover diminishing the gap between public bank rates and private market rates would represent a reduction of about 51% in this measure in the same year.

1 Introduction

One of the most current topics in economic development concerns differences in the level of income between countries. What factors could help explain why some countries have such a low level of income and economic growth compared to developed nations?

In Brazil this seems to be an issue that is never exhausted. Factors that have been sug-

gested include barriers to entrepreneurship and difficulties of doing business, prohibitive burdens in the supply chains, lack of competitiveness, high concentration of informality in commercial establishments, tax distortions, poor and insufficient education and inadequate infrastructure, to name a few of the abounding points related to the topic. Many economists have insisted that the country must leave commodity exporter conditions to modernize, significantly increase the minimum wage relative to international peers, or even massively subsidize credit for strategic sectors. Although all strands analyzed have some kind of solid premise, many do not focus on one point of paramount importance: productivity.

Countless issues are linked to the low productivity per worker in Brazil; from a precarious infrastructure, poor educational quality, many bureaucratic barriers, business activity in the country, to by not-so-sound institutions. All of these points together contribute to the explanation of why some nations are more efficient in the utilization of their stock of capital (physical and human) and, therefore, are more productive.

A recent study conducted by McKinsey, a Global Consulting firm, published in 2014 revealed that labor productivity in Brazil is low and has failed in showing a satisfactory gain to support economic growth in the country. Only 40% of the GDP growth from 1990 to 2012 in Brazil came from an increase in the labor productivity, while the remaining percentage – the higher contribution – was accounted for by a dilatation in the workforce due to demographic reasons and diminution of unemployment. The situation is alarming, since it contrasts with that of other large emerging countries, which have similar output per worker to Brazil, like India and China are performing better in this topic than Brazil. The contribution of labor productivity for economic growth in these countries was 67% and 91%, respectively. Even more unsettling in this study is the prediction done by McKinsey that the factors responsible for economic growth in last decade tend to decrease significantly in the next few years. Therefore, following this line of research, a great number of economic papers have considered the reasons behind marked discrepancies in the countries' productivity.

In this paper, I will focus to one of the most plausible causes of the disparity in productivity across countries according to recent studies: misallocation of resources. There are

many reasons attributed to this, and one of them is the misallocation of resources across firms. Many authors have studied misallocation arguing that how inputs are allocated across firms is an important fact to understand why some of them are more productive and efficient than the others.

For example, Guner, Ventura and Xu (2008) study the effect of “dependent policies”, as they called there, in misallocation. They considered government policies such as restrictions on the size of large units in some countries. They found that policies that distort the size of firms can have a deleterious effect on productivity. For example, the reduction of establishments size imposed by regulations leads to a contraction of 8.1% in the output in OECD countries. Conjointly, Lileeva and Trefler (2010) focus their paper on trade barriers as a possible cause of misallocation, exploring the relationship of international trade with productivity. They used data for plant-specific tariff cuts in Canada and found that plants once not productive, after receiving tariff cuts, started exporting more, investing in innovation, and obtained, as a result, an increase in labor productivity of about 25%. They also noticed that these new Canadian exporters also expanded their market share. Another important cause of misallocation comes from regulation and taxation, particularly if this is uneven among firms. Ordonez (2014) assesses the effects of incomplete tax enforcement on informality. Using data for Mexico he found that tax distortions can potentially lead to informality and misallocation of resources through a reduction of capital-labor ratio in firms. Consequently, the aftereffect is a reduction of output per worker. By his model, with a restructuring of the Mexican tax enforcement, labor productivity would be up to 34% higher.

The purpose of this paper is to analyze misallocation due to asymmetric access to subsidized loans across sectors in Brazil and how the discrepancy between public bank rates and private market rates can impact the contribution of BNDES (Banco Nacional do Desenvolvimento Econômico e Social, or National Bank of Economic and Social Development, in English) dispersion to TFP (total factor productivity) loss in the country. The main goal of this study is to provide quantitative evidence on the role of recent policies focused on BNDES, a public bank in Brazil responsible for promoting long-term financing to companies, as a potential source of distortions and misallocation.

BNDES has been used for years to fund strategic sectors chosen by government in an attempt to create the national champions of the country. The bank grants low-interest subsidized loans to sectors previously chosen and, theoretically, these sectors would have to invest this money, increasing production and, thus, improving the country's economic performance and wealth generation. The recourse for these loans comes from the National Treasury budget and there is a great disparity between interest charged by BNDES and that by private banks in other types of loans, so sectors not privileged by subsidized credit end up paying much higher interest rates, or cannot access resources to invest. This practice is a potential case of resources misallocation and it can have an impact on aggregate TFP. The idea behind this is that economic activity in Brazil has been heavily influenced by the intensive use of BNDES as a political policy, by injecting subsidized credit, with interest rates far below the market, into companies in the sectors chosen by BNDES. Moreover, this selection of the leading sectors is not transparent and it could be the case that less productive sectors could be politically favored and receive disproportionately more loans than other sectors, being benefited with an interest rate almost half lower than the rates of private banks. Aside from that, it could be the case that large companies with enough financial health to borrow in the market were given subsidized credit, without this necessarily translating into productivity gains. It is a typical case of potential misallocation, especially in Brazil when there is an enormous premium over the subsidized rate over the market rate, which means that if the selection of recipients is not economically efficient, some relatively productive companies that have no possibility to access subsidized rates, cannot invest more in production. Therefore, the goal of my study is to analyze if BNDES policy is associated with misallocation and, consequently, lower than efficient TFP. To do so, I can directly calculate if the difference between BNDES interest rates and private market rates can have an impact on the BNDES contribution for TFP loss.

On the grounds of this potential distortions in Brazil, it is important to address some points: Are the cheap money going to the most or least efficient sectors? What is the contribution of subsidized BNDES loans to the TFP loss in the Brazilian economy? And, if there is, in fact, a misallocation in this policy, how much could the TFP in Brazil

improve if this specific BNDES distortions was removed, compared to the current TFP level? To answer these questions, I use a standard model of perfect competition across heterogeneous sectors, assuming a Cobb-Douglas technology of sector, based on Chen's (2017) version of Hsieh and Klenow (2009)'s paper. In this model, I assume there are exogenous distortions in capital and output for the sector-level, and these distortions have an impact on revenue productivity of each sector, and consequently, on the aggregate total factor productivity. Apart from that, I assume it is possible, in the model, to account for TFP associated with all distortions excluding BNDES, so I can also calculate the revenue productivity and total factor productivity based on distortions net of BNDES effect. By doing this, I can establish a relation between them and calculate the gain in aggregate TFP by eliminating the specific dispersion in BNDES.

My data include direct measures for sector-level distortions in the form of the distribution of subsidized loans across sectors. I incorporate a model where distortions can impact the aggregate TFP, since wedges in marginal product of capital across sectors will lower the productivity. Ideally, in the absence of any source of distortion, marginal products should be identical across sectors. I use sector-level data from PIA (Produção Industrial Anual, or Annual Industrial Survey, in English), PAC (Pesquisa Anual de Comércio, or Annual Commercial Survey, in English) and PAS (Pesquisa Anual de Serviços, or Annual Services Survey, in English) (2003 – 2014) to access data for production, labor and capital; likewise, I use data from BNDES loans by sector in 2014 to calculate the potential distortions. I also use loan data from 2003, 2008 and 2011 in a second round of calculation to exploit different scenarios.

My contribution with this paper is to conduct a quantitative analysis of this important issue by taking a direct approach to effectively calculate the dispersion in subsidized loans and contribution of BNDES dispersion to TFP loss. Although the existence of allocative distortions in the Brazilian productive structure is a notorious fact, few empirical studies have been done in this field, and there is still room for quantitative analyses that deal with misallocation, especially when it concerns the BNDES or other such development policies. Also, many other studies have taken an indirect approach to the measurement of misallocation, making it more difficult to write a credible model specification, since the

source of the distortion is not precisely identified. Supplementary to that, I investigate the potential welfare gains of eliminating BNDES distortions in the aggregate productivity. For this reason, this paper makes a contribution to the analysis of misallocation, especially for the Brazilian context.

To account for BNDES contribution I calculate the BNDES dispersion using a weighted average between subsidized rates and market rates, based on data on actual loans from Central Bank. My results suggest that distortions associated with cheap loans from BNDES correspond to around 23% of TFP loss in the sector-level for 2014, which means total factor productivity levels would face a 23 percentage-points gain if the BNDES dispersion were removed. Apart from that, my results show that there is a TFP loss associated with all types of distortions in the Brazilian economy of 41% in 2014, indicating that sectors in Brazil are almost half less productive than it could efficiently be if there were no misallocation. To account for economic and political differences over periods, I also run the same exercise considering a variation of scenarios and years. My results suggest that the way parameters are calibrated impact the bank contribution to TFP loss; when the share of output paid to capital, α , was calibrated as one single value for all sectors, instead of considering different α for each sector, the contribution of BNDES dispersion to TFP loss was 19%, lower than the 23% obtained before; and when the elasticity of substitution σ was changed from 3 to 2, the result of contribution of BNDES dispersion to TFP loss was 30%, higher than the first scenario. Similarly, I run the same exercise considering different years (2003, 2008 and 2011) and the results also changed. Periods when the difference between BNDES rate and private market rate was high, also showed a high contribution of the bank dispersion to TFP loss, compared to the first scenario (2014). In 2008, the BNDES contribution to TFP loss was around 14%, in 2008 this number was 18% and in 2011 it was 32%, the highest value for this measure. Supplementary to that, I also evaluate that BNDES subsidized loans are not necessarily going to the most productivity firms, which could be a possible indication of misallocation. By taking logs of BNDES loans received in 2014 and revenue productivity in the same year, by each sector, it can be seen there is a negative relation between these measures. This fuels the suspicion that, in fact, the biggest beneficiaries of this development policy

are not the most productive sectors of the economy, but rather the ones with best political connections.

Beyond that I run an extra exercise, calculating how much this BNDES effect could be minimized if the rate would be paralleled with market rate, which is a proposal discussed in the Congress. I found that the BNDES contribution would fall to around 12%, indication there is a room for nearly 51% reduction in the contribution of the public bank in TFP loss if this proposal is approved and BNDES rate reformulated to fit a more realistic scenario.

The rest of the paper is organized as follows: Section 2. Literature Review, where I present what has been debated about misallocation in recent literature and the contribution these papers and their findings have brought to the analyzed field; Section 3. BNDES: background, where I explain the origins of the public bank, its initial mission and how it has been changing over time, culminating in its tremendous participation in the political spectrum of the last 10 years and the consequences this has brought to the economy; Section 4. Data, where I describe the Data used in the paper and how the variables are build; Section 5. Model, where I present the economic model that will serve as the basis for the calculations of BNDES dispersion, based on Chen (2017); Section 6. Methodology, where I discuss how the model is brought to the data; section 7. Results, where I show the results obtained from the model; and Section 8. Conclusion.

2 Literature Review

Much has been addressed on the subject of development and differences among countries in recent years with important contributions. Misallocation is a very relevant topic discussed among economists, since it is pointed out as one of the main causes for the difference in income per capita across countries, in addition to other factors. Here is a literature review of influential papers about misallocation and their findings.

Pavenik (2002) uses data from manufacturing sector in Chile to study the direct effect

of trade liberalization on firms output results, motivated by a wave of privatizations that occurred in Chile in 80s, marked by international economic openness, elimination of trade barriers and some tariffs, and palliation of some restrictive regulations. The idea is to test the hypothesis that such wave of liberalization created a competition environment with external companies that could damage the domestic market. Contradicting some of the existing premises, his results suggest Chile observed a period of productivity improvement after trade liberalization, even when controlling for plants closing and units specialized in import-export business. The findings indicate that a greater competition with foreign companies forced domestic firms to become more productive to continue in the market, which was beneficial to economy growth in the country. Besides, although some plant did exit after the wave of privatizations, the paper concludes that they just left the market because they were about 8% less productive than their domestic peers and, because of that, the exiting did not have a negative impact on the aggregate output.

Khwaja and Mian (2005) analyze the role of corruption in misallocation, where the corruption may be interpreted by “politically connection”; the great contribution of this paper for the theme is exactly the quality of data they have: since they are able to find meticulous data for corporate lending in Pakistan, they can test at individual level. They find that firms whose directors participate in an election are favored by government and borrow about 45% more and have 50% higher default rates. Also, they find that this preferential treatment occurs exclusively in government banks. They used fixed-effects to study possible variation effect within the same firm over time and across lenders type, so they can have a clear measure of the impact of political status in borrowing. They find that public banks differentially favor politically connected firms by providing greater access to credit.

Alfaro, Charlton, Kanczuk (2008) investigate some plausible reasons behind cross-country differences in income per worker, focusing mostly in discrepancies in resources allocation across assorted plants. With data of more than 20 million producers’ establishments in 80 countries, from developing economies to industrialized ones; they calibrated the model incorporating factors that could have side effects in the final output. To do so, they needed to find plants structure of taxes and subsidies, distributed by size, and

incorporate distortions, like different types of policies such as non-competitive banking systems, product and labor market regulations, corruption, and trade restrictions. By taking US as a benchmark they could calculate how much aggregate output is wasted due to distortions and the results indicate that the factors calibrated in the model can explain 58% of the log variance of cross-country income dispersion.

Restuccia and Rogerson (2008) run a quantitative analysis to investigate factors that might help to explain differences in productivity across countries. The authors emphasize that firms with different levels of productivity tend to allocate their productive revenue conflictingly, creating an asymmetry in output per capital across countries. The authors state that if some policy alters prices directly affecting different establishments, even if it does not change the aggregate relative prices, it will impact the allocation of resources. To account for this, they introduce some distortions in prices that will affect producer's preferences differently, such as levy taxes or subsidies, and observe a redistribution of resources, as consequence. The results indicate distortions of this nature can diminish output and productivity by up 30% or even 50%.

Hsieh and Klenow (2009) run an empirical study of resources misallocation and lower TFP, their paper brings important analysis in this field. They claim that in the absence of any distortions, revenue productivity should be similar across firms. Apart from that, they can measure the effect of misallocation on manufacturing productivity in China and India, compared to US. They showed that reallocating capital and labor across firms such that they would be paralleled to marginal products level in US (or move to "US efficiency", as they called), would represent a 50% gain in China's TFP and 60% in India's TFP for the manufacture sector.

Buera, Moll and Shin (2012) investigate the effect of "well-intended" policies on the aggregate output and productivity. Some policies, like subsidized loans, have the intention to grant credit to small business that have difficulties to access the private market, due to financial frictions. However, the results suggest that, although there are some benefits in the short run, the long-run impact might be nefarious. The point made by the authors is that subsidies are specific to firms in need and they will hardly be removed, but individual productivities tend to move back to the average after some time, like a stochastic process,

creating a distortion. They conclude that incentives to run a business are distorted by the subsidies, since some large companies continued to receive credit facilities from the Government even when they show a poor productivity in the subsequent years. They argue this finding helps to explain why some countries observe a very prosperous economic cycle in response to some development policies and after a while fails again.

Gao (2013) extends the study conducted by Hsieh and Klenow (2009) to capture distortions that happen also across sectors. To do so, they used data from China manufacturing sector from 1998 to 2007 to directly incorporate elements like labor and capital frictions across sectors from different regions in the country, they called these frictions “systematic frictions”. Also, controlling for distinctive residuals, such as location of firms (rural areas or big financial centers), financing costs of capital, type of business (private local business or state-owned enterprises), they can make a substantial contribution to the analyzes of misallocation. The results show that the improvement of allocative efficiency led to a contraction of labor distortion across regions and also a reduction of capital distortion across segments during the period studied. Over the years, these frictions decreased, resulting in less than one fifth of the distortions in labor and capital markets. The findings indicate that the greater flexibility in labor and capital markets in segments and regions studied was key to increment efficiency and diminish misallocation over time.

Midrigan and Xu (2014) address the theme by focusing on finance distortions, more specifically conditions for obtaining credit and how the difficulty of borrowing can negatively impact aggregate TFP. To run this study, they use data of manufacturing plants in Korea and Colombia, countries that differ in finance markets maturity levels, to analyze frictions. One of the contributions she made is to built a model where substantial elements from the data, like differences in returns to capital and output, could be captured and controlled at the plant level, doing a more precise approach. Their calculations indicate a TFP gain of 5% when a scenario of US level external borrowing is introduced. Besides, they also found that the internal savings over a long period of time can overcome credit constraints and help to eliminate frictions.

Moll (2014) run a model based on general equilibrium to evaluate the effect of financial frictions on capital misallocation in an economic environment where heterogeneous

firms face collateral constraints. The dominant idea in a great number of studies is that imperfections in credit markets make it impossible for some firms to have access to them and increase their investments, and it would be the reason behind low income per capital in some countries. She identified one very important aspect, still ignored in some analyzes, that could bring different conclusions: people can overcome lack of financial resources through savings, which is called in the paper as “self-financing”. The possibility of accumulations over time can even eliminate the effect of capital distortions on productivity. The results indicate that when shocks in output are temporary and productivity gains are permanent, the frictions affecting output become less influential in the path to steady state and entrepreneurs have more time to accumulate internal funds. In this sense, self-financing becomes more efficient in the long-run, defeating the side effects of financial frictions and stabilizing the allocative transfer of capital between producers.

De Bolle (2015) analyzes the effect of development policies conducted by public banks over the monetary policy in Brazil. The author obtained interest rates data in Brazil from 2004 to 2014 and estimate how the subsidized credit granted by public banks during the period impacted real rates. The main idea behind her paper is that the excessive use of subsidy policies by the Government creates an environment that pressures domestic rates upwards. The results indicate that interest rates in Brazil are affected by lending money; according to her calculations when Government increases the subsidized credit in 1% as GDP share, internal rates go 0.5% up. The author also states that it happens because Government uses Treasury money to concede loans, lending at very low rates. The problem is that these rates are not driven by changes in monetary policy and because of that responsible authorities need to do more effort than it should be bringing inflation to the target midpoint.

Fajgelbaum, Morales, Serrato and Zidar (2016) study how economic activity and aggregate macroeconomic variables would be impacted by a modification in US state tax structure, considering that states are heterogeneous in their taxes system. One of the paper’s contribution is to introduce preferences related to mobility, not only for labor-force, but also for public services. The findings indicate that the elimination of tax dispersion could implicate in a welfare gain higher than the tax revenue share in GDP, not

considering public spending.

Kuwer (2016) runs a quantitative analysis focusing on the earmarked credit in Brazil as a potential source of misallocation. According to him, the structure of public loans in Brazil is associated with distortions, leading to differences in marginal returns to input across firms. He obtained data for main types of subsidized credit in the country, including also rural and housing credit; with the data, he used a general equilibrium model incorporating firm size distribution, inequality and aggregate productivity. The goal is to test the hypothesis that resources do not go to most productive firms when there are distortions in earmarked credit and it may force some high-productive units to produce below the optimum level, reducing the aggregate productivity. Although some policies targeting high-productive agents can be positive under certain circumstances, he found that most of these policies create cross subsidy and harm some agents through congestion and higher costs to access capital in the market, especially if the target of subsidized credit fails to be achieved.

Chen (2017) evaluated the benefits of a revenue tax reform from the perspective of gains in productivity. To this end, the author measures how much would be the increase in aggregate TFP if distortions in VAT for the manufacturing sector in China were eliminated, which would also help to simplify tax rates along supply chains. The author uses a direct calculation approach based on a monopolistic competition model, including human capital, where he can investigate production efficiency and measure VAT distortions. The author finds that aggregate TFP could increase around 8% of average GDP if such reform eliminated those taxes distortions.

The papers discussed above show how that resources misallocation may lead to significant losses of productivity and when it is associated with credit restriction or financial constraint it may also limits the optimal choice of resources between productive and unproductive agents. Some government policies can mitigate the inefficiencies when well structured. My papers is linked with the recent literature in the sense that shows how distortions in public credit allocation can lead to TFP losses in Brazil and how it could be reduced if the gap between public and private interest rates was diminished.

3 BNDES: background

BNDES (Banco Nacional de Desenvolvimento Econômico e Social, or National Bank for Economic and Social Development), also known in Brazil as "National Bank" is a Brazilian public bank that was created in 1952, in the presidency of Getúlio Vargas, as an autarchic entity, with administrative autonomy and own legal personality, initially under the jurisdiction of the Ministry of Finance. According to a report made by the bank, titled "BNDES: Um banco do futuro (2012)", or "BNDES: A bank of the future", in English, to celebrate the 60th anniversary of its foundation, addressing its history, values and mission, it was founded with the aim to cede loans and credit for companies which could develop a project with a clear and measurable social and economic benefit for the Brazilian society in the long-term. The publication emphasizes that its motivation was to foster some vital areas and sectors for the development of the country, especially in an age with high interest rates for credit and inflexible access to the market for medium and smaller companies. It was a development policy for the industrialization of the country.

In the early years, as presented in the BNDES report published in 2012, initial operation was related to providing credit to specific sectors, such as energy, the steel and mining industry and transportation; however, after a while the scope of the Bank, following a strategic plan for national development in Brasília, seat of federal power, focused on selected firms in very specific sectors, choosing the “national champions”. Initially, the main source of funds would come from the “Economic Recovery”, which consisted of additional fees on income tax, in addition to some compulsory deposits from technical reserves of insurance.

During the 60s and 70s, the Government engaged in a joint commission with the United States to expand the infrastructure projects in Brazil and BNDES played a key role in this process. The publication states that the bank’s capacity to provide loans to a great number of “basic industries” through a mechanism of long-term loans with subsidized interest rates was greatly expanded. At this time, Brazil was a largely agricultural country, with a small number of industrial firms, which was a concern for the Federal Government. Almost every good consumed in the country came from Europe or US. Be-

cause of this the subsidized loans to the nascent industry was part of a national program of accelerated industrialization, with the intention to overcome the underdevelopment of the Brazilian economy and diminish the external dependence. The industries that first received the benefits of this government program, according to the BNDES report, were metals, chemicals, cement, and oil.

The mission was to assist them in the formation of productive investment. The Bank should also be responsible for carrying out economic analyzes and, based on that, identify the main structural problems of the country. According to the publication, the pursuit of this policy was to increase the local production of essential goods; adapt Brazilian industries to a more advanced technology, to produce substitutes for those commonly imported products by improving infrastructure, especially the modernization of the precarious public transport; and to better channel savings for industrial activities.

In the early 1980s, there was a transfer of authority from the bank, going from the Ministry of Finance to the Ministry of Planning, and this period was marked by an expansion in bank's activities. BNDES started investing more directly in the equity of Brazilian companies. The Governing Council of the bank has developed some programs for this purpose, such as the Financing to Shareholders and the Capitalization Support Program of the National Private Enterprise. The goal was to inject resources directly into specific projects that would stimulate the primary stock market in the country. BNDES started to manage those holdings and assumed the mission to capitalize national private companies, and to strengthen the capital market in the country. In the same period, following the changes in the Brazilian economy, the National Bank inaugurated a new episode of its history, also acting in the application of the scenario-building methodology in the strategic planning process. The elaboration of the scenarios redirected its policy in order to integrate it into the international context.

The 90s were marked by new challenges for the country's economy. Due to the economic stagnation of the times and galloping inflation, a wave of privatizations accompanied by greater openness to international trade occurred in the country in order to modernize the national industry and make it more competitive, aiming at a better balance of public accounts. BNDES was an active participant in those reforms, in three

ways: planning and executing privatizations, providing necessary loans, and purchasing minority stakes in several former state-owned enterprises.

It was in the two administrations of President Luiz Inácio Lula da Silva (2003-2010), followed by the administration of President Dilma Rousseff (2011-2014), that BNDES was used most intensively, with a substantial increase in transfers of Treasury resources and financing of large companies in a much more vigorous way. The Bank was also involved in several large-scale operations and helped orchestrate mergers and acquisitions to build “national champions” in several industries. From then on, the scope of the bank’s performance became a growing target of political and economic criticism. As one of the pillars of Government, the aggressive policy of BNDES loans aimed to create major companies subsidized with Treasury funding to promote economic growth.

BNDES is now one of the largest state-owned development institutions in the world. In response to the global crisis of 2008, the Bank started to play an even more direct role in corporate finance. Some companies, considered vital, began to receive massive investment, at subsidized interest rates. The National Bank is one of the main lenders in the country, playing a significant role in the promotion of credit in Brazil. Figure 1 below shows the evolution of lending in the country in the last 10 years as a percentage of GDP (gross domestic product), a period when BNDES loans have intensified considerably. It is possible to notice that the percentage of credit as % of GDP more than doubled in the period, jumping from 10% to about 27%, evidencing how these years were marked by a considerable growth of credit in the Brazilian economy.

One of the concerns regarding these transfers was the criteria for granting credit: the greatest beneficiaries of the BNDES were large companies, already consolidated in their sectors, which had great access to capital and could already obtain credit at market interest rates. The goal of the bank is to increase the investment capacity of small and medium-sized firms that do not have access to credit, granting low interest rate loans to invest in projects with a positive economic and social impact. Thus, the concern of some

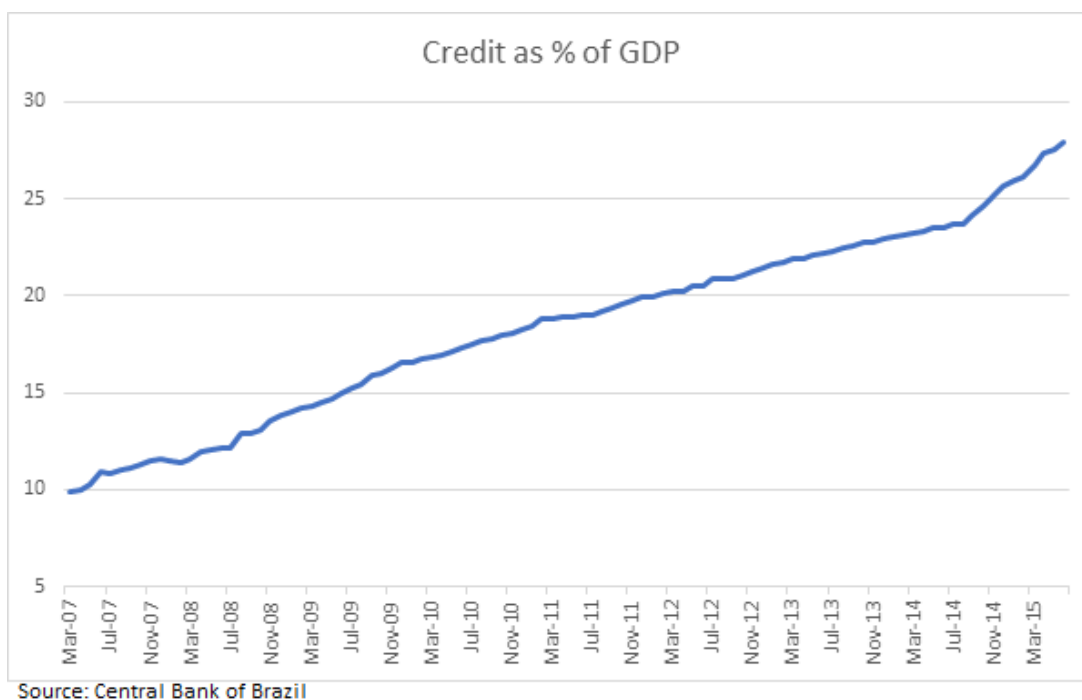


Figure 1: Evolution of credit in Brazil, as a percentage of GDP

economic analysts was that the bank would be assuming the role that should had been given to the market and could thus generate allocative distortions, since the benefited companies gained market power, could raise prices and remained protected against competition, which discourages investment and innovation. BNDES, as a fomentation bank operating with public money, is expected to accurately select their beneficiaries; these, in return, should use the resource in their production through investments. Another problem, there is no complete transparency about the process of selection of those firms. The Bank only started to provide full information on the loans a few years ago, after 2010, and since it started to publish the reports there is no explanation for the specific criteria of selecting beneficiaries.

One recent study conducted by Monica de Bolle (2015) illustrated how public lending by BNDES may have had a deleterious effect on interest rates and productivity growth in the economy. Evidence suggests that although the Bank acted as an anticyclical instrument in the past, helping to booster the economy in stress times, it is also a major contribution for macroeconomic distortions in the country. The results indicate that when BNDES increased the amount of loans in 1% as a percentage of GDP, the domestic rates

in Brazil went up around 0.5%. Moreover, there was a negative effect of BNDES loans on TFP of almost 30%, according to the paper, which contributes to the hypothesis of distortions in the policy chosen by the bank. Because National Treasury has been one of the greatest financial supports of BNDES, this policy has been criticized by experts who state that increasing the transfer of public resources to finance selected sectors with interest rates far below the private market levels might have negative consequences for the economy.

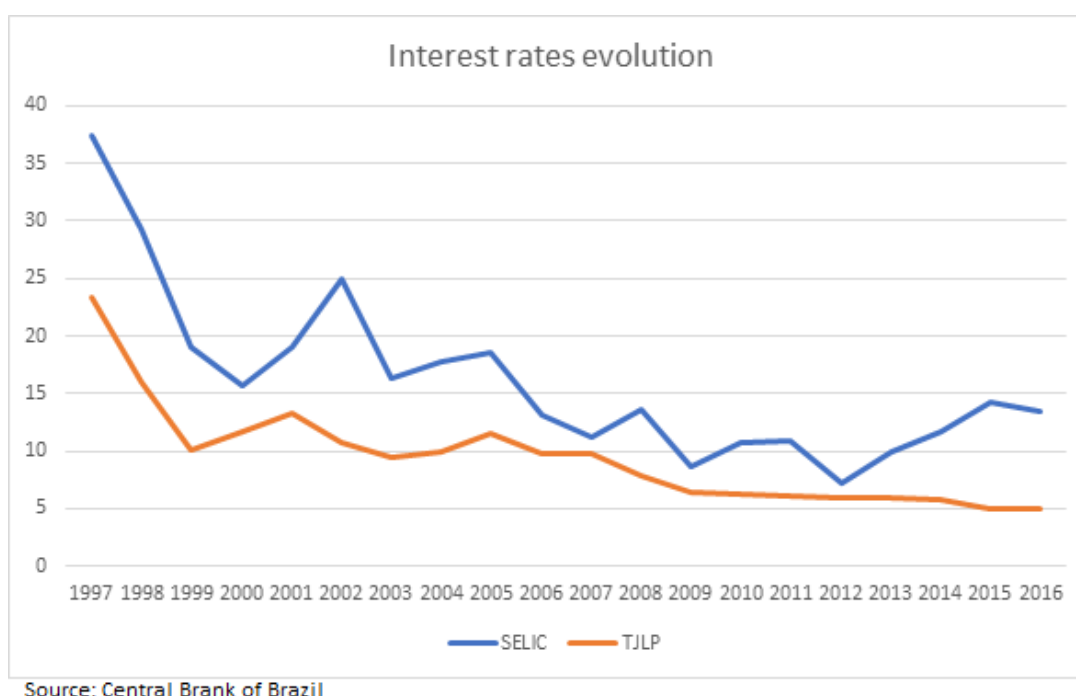


Figure 2: Evolution of interest rates in Brazil

In this paper, I will focus on the subsidized loans provided by BNDES. The operational system works as follows: National Treasury borrows money from market and pays the current rate, which reflects SELIC (Sistema Especial de Liquidação e Custódia, or Special Settlement and Custody System, in English) trends, an index by which the interest rates charged by private banks in Brazil are based. After that, with this money, Treasury can fund BNDES, which select the “national champions” that will receive loans at TJLP

(Taxa de Juros de Longo Prazo, or long-term interest rate, in English), a fixed rate. Here it is the source of subsidy: TJLP is not as sensitive to fluctuations due to economic or political changes as SELIC does. In 2014, base year for my quantitative analysis, SELIC was around 13% yearly and TJLP about 6%, which is a sizable difference. Therefore, the sectors benefited by the BNDES obtain subsidized credit at an interest rate that is more than 50% lower than the market rates, and once the loan is granted, this rate will be fixed until the end of loan agreement.

Figure 2 shows the evolution of the basic interest rate – SELIC - in the Brazilian economy, concomitantly with TJLP. It is apparent that TJLP is always below SELIC. Both rates - SELIC and TJLP - followed the same trend until 2006; however, from the beginning of 2007 TJLP has remained stable at the same level (around 6%), while SELIC has oscillated heavily, showing a rapid increase from 2011. The problem here is that SELIC rise was not accompanied by the BNDES rate and SELIC is the reference rate for private loans in Brazil; when firms need to access credit they usually pay SELIC plus a premium over risk, while public loans are based on TJLP. The disparity between these two rates is a target of great criticism in the Brazilian context, since it is seen to have detrimental consequences for the economy and is a potential source of distortions.

This policy has been one of the pillars of economic strategy in recent years. As a consequence, Treasury spending has increased considerably, sectors not privileged by the criterion of selection end up having more difficulty to obtain credit in the private market, since interest rates are very high. Besides, subsidized rates do not react to Central Bank policies the same way private market rates do. This scenario creates the background for my analysis, where this disparity in both rates is a potential source of misallocation.

The empirical results of recent papers, such as De Bolle's (2005) and Kuwer (2016), suggest the specific subsidized financing by National Bank in Brazil is a source of distortion in the economy, causing more harmful effects than good ones, since BNDES loans direct and indirect effect via real interest rates have a negative repercussion on productivity growth, according to De Bolle's (2005) paper. This environment may have other negative effects on the economic activity in the country, as well. It seems clear that the way BNDES loans policy is conducted can represent a potential source of misallocation, and

the effects of these distortions seems to be harmful to the economy in different levels.

4 Data

My database is composed of two important pillars: on the one hand, variables that will be used to calculate the productivity of the sectors studied and, on the other hand, variables related to the subsidized loans received by these same sectors.

From the productivity side, my data is drawn from three main sources: PIA, PAS, and PAC from 2003 to 2014 fiscal years, annual surveys for Industrial, Services and Commercial sector, respectively. They are conducted by IBGE (Instituto Brasileiro de Geografia e Estatística, or Brazilian Institute of Geography and Statistics, in English), a public organization responsible for the collection and management of data and statistics. To be eligible to participate in the survey, the firm or conglomerate must be active in the Central Business Register and properly registered in the Annual Social Information Report of the Ministry of Labor and Employment. Also, it is mandatory that the firm have at least 5 or more people occupied in production. From these prerequisites, a census survey of companies with 30 or more employed persons is then conducted. Although there are more than 50 sectors covered in these surveys, I used only those that were also listed in the BNDES database. From the surveys listed above, I used the variables added value, working force (occupied workers in the production), salaries, investments, and depreciation.

PIA investigates information regarding products and services produced by industry, based on a pre-established nomenclature elaborated by IBGE from the National Classification of Economic Activities (CNAE 2.0) and the Mercosul Common Nomenclature. Its content captures all the registered manufacturing plants in the Brazilian industry (about 100,000 firms analyzed), and is publicly available at the sector level. The data presented in this survey includes the composition of industrial production, such as goods produced and sold, values of production and sales, profits and costs related to the production,

investments and depreciation, number of workers in each industry and their salaries.

PAS provides statistics on the productive structure of services sector other than financial in Brazil, reporting the behavior of formal services market. The focus of this Survey is to collect data from specific services categories, such as services provided mainly to families; information and communication services; professional, administrative and complementary services; transport, ancillary transport services and mail; real estate activities; and maintenance and repair services, as well as other activities. It dispenses information related to revenues, personnel employed, personnel expenses, other costs and expenses, value produced and added value by production. This survey includes around 50,000 companies in the services sector. Finally, PAC provides exactly the same variable information that PAS gives, but focusing on the characteristics of the commercial sector in Brazil, especially the wholesale and retail segments, and commercial representatives. It includes 80,000 companies in the sector.

In the surveys discussed above, “added value” represents the values corresponding to wealth formation generated by the company resulting from the activities related to production. Basically, it is calculated from the difference between the value of production and the costs of goods and services used in this process. In the calculation of “added value”, the Institute takes into account the aggregate measures of firms activities, such as costs, raw material consumption, and production sale to compose the parameter used in the apportionment of the desired variables. Hence, a sum of local productive units is made to obtain the added value in each specific sector. The measure for salaries is achieved by the questionnaire filled in by each productive unit with values for all compensation received, and then adjusted considering possible social and labor charges, indemnities, and benefits. Similarly, the “labor” variable represents the total number of workers linked to the production in each sector, also based on the questionnaire, but with no adjustments.

My measure for “capital stock” is obtained by the perpetual inventory method. I used the values of investments (variable determined by the magnitude of resources invested, each year, in the purchase of durable goods for the operation of the local unit) and depreciation (variable determined by a weighted calculation of financial expenses, monetary variations and negative results of equity holdings) to calculate the capital stock. The

perpetual inventory method consists in treating the capital stock as an inventory, which increases with investments and capital formation, and decreases over time, due to devaluation of the investment for its use and obsolescence. Hence, the capital stock in a given period is equal to the weighted sum of the investments done over time discounted by the depreciation rate.

For the loan size, my database is drawn from BNDES statistics regarding the volume of subsidized loans the National Bank has transferred to sectors related to industry, services and commerce. A point of extreme importance for my model is that the data are placed on the National Classification of Economic Activities (CNAE 2.0) nomenclature, exactly the same classification for PIA, PAS and PAC data. Since all the Surveys and Databases used in this paper contain information structured in the same sector nomenclature, I can match and compare them at the sector-level and run a quantitative exercise to investigate if the loans are designated to the most efficient sectors in the Brazilian economy and, in the presence of distortions, what is the contribution of BNDES to the TFP loss. I also used the historical series of interest rates in Brazil, published monthly by Brazilian Central Bank, where there is information about the market interest rates for non-earmarked loans, and the rates charged for subsidized loans from BNDES.

5 Model

My model is adapted from Chen's (2017) version of Hsieh and Klenow's (2009) study. I assume that each sector (i) is operating in a monopolistic competition environment market and that each representative sector (i) produces a final good Y , which is the final output. The final output is produced by the sector with a Cobb-Douglas technology as described in equation (1), where K_i is the sector-level physical capital input and L_i is the labor input. A_i represents the TFP.

$$Y_i = A_i K_i^\alpha L_i^{1-\alpha} \quad (1)$$

The total output of all sectors (M) in the model is described by a CES technology, where Y_i are the outputs of each sector that produces Y , as described in equation (2).

$$Y = \left(\sum_{i=1}^M Y_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (2)$$

where σ is the elasticity of substitution between different inputs.

Now, I consider that sectors are facing one direct type of exogenous distortions in capital relative to labor τ_{K_i} . I am also assuming there is another type of exogenous distortion, in output, τ_{Y_i} . In the absence of the capital distortion, output distortion should be none. The subsidized loans granted by BNDES create a wedge that directly distort the allocation of capital. For example, sectors with little access to subsidized credit would face higher τ_{K_i} ; on the other hand, sectors where firms are well connected and can have cheap loans would face much lower τ_{K_i} .

The sectors want to maximize their profits, taking as given the distortions they are facing. It is expressed by equation 3.

$$\Pi_i = (1 - \tau_{Y_i}) P_i Y_i - r(1 + \tau_{K_i}) K_i - wL_i \quad (3)$$

where r is the market rental price of physical capital, and w is the effective wage rate of labor force and τ_{K_i} and τ_{Y_i} are the distortions mentioned above.

The condition for the output price comes from the profit maximization as:

$$P_i = \frac{\sigma - 1}{\sigma} \left(\frac{r}{\alpha} \right)^{\alpha} \left(\frac{w}{1 - \alpha} \right)^{1-\alpha} \left(\frac{(1 + \tau_{K_i})^{\alpha}}{A_i(1 - \tau_{Y_i})} \right)$$

The first – order condition for the maximization problem with respect to the inputs (capital and labor) are:

$$MRPK_i = \alpha \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{P_i Y_i}{K_i} \right)$$

$$MRPK_i = r \left(\frac{1 + \tau_{K_i}}{1 - \tau_{Y_i}} \right) \quad (4)$$

$$MRPL_i = 1 - \alpha \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{P_i Y_i}{L_i} \right)$$

$$MRPL_i = w \left(\frac{1}{1 - \tau_{Y_i}} \right) \quad (5)$$

The equations (4) and (5) give us the marginal revenue product of capital (MRPK) and the marginal revenue product of labor (MRPL). The maximization is obtained based on the fact that $\sigma-1/\sigma$ denotes the constant markup of price over marginal cost.

It is clear that, by this model, distortions have an impact in the allocation of resources across sectors and because distortions lead sectors to allocate resources in an inefficient way, there will be differences in the marginal revenue products of the inputs showed above.

Equation (4) shows that MRPK is equal to the market rental price of physical capital (cost of capital) times a ratio of the two distortions. Correspondingly, equation (5) states that MPRL is equal to wage of labor force times the wedge caused by the output distortion.

Following the maximization problem, I am ready to set an equation for the revenue-based total factor productivity of the sector(i), $TFPR_i$, taking the distortions into account and expressing them in terms of adjusted-prices, which incorporates the marginal revenue products of the inputs. I follow Chen (2017) model to set the revenue productivity as the equation below:

$$TFPR_i = \frac{P_i Y_i}{K_i^\alpha L_i^{1-\alpha}} = P_i A_i$$

$$TFPR_i = \frac{\sigma}{\sigma - 1} \left(\frac{MRPK_i}{\alpha} \right)^\alpha \left(\frac{MRPL_i}{1 - \alpha} \right)^{1-\alpha} \quad (6)$$

where $MRPK_i$ was obtained before as $r/(1+\tau_{K_i}/1-\tau_{Y_i})$ and $MRPL_i$ was obtained before as $w/(1-\tau_{Y_i})$. So, we can also express equation (6) as:

$$TFPR_i = \frac{\sigma}{\sigma - 1} \left[r \frac{\left(\frac{1+\tau_{K_i}}{1-\tau_{Y_i}} \right)}{\alpha} \right]^\alpha \left[w \frac{\left(\frac{1}{1-\tau_{Y_i}} \right)}{1 - \alpha} \right]^{1-\alpha} \quad (6)$$

By equation (6) it is possible to see that sectors with higher distortion in capital relative to labor, τ_{K_i} , and consequently higher distortion in output, τ_{Y_i} , will have a higher $TFPR_i$. The efficient allocation of resources would happen in the scenario of $\tau_{K_i} = \tau_{Y_i} = 0$, when no variation in $TFPR_i$ is observed.

From the maximization problem in equation (3) I have found the marginal revenue product of capital in the equation (4), from which I can calculate the parameter $(1+\tau_{K_i})/(1-\tau_{Y_i})$ as a function of the other parameters of the model. The next steps show this relationship:

$$\alpha \left[\left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{P_i Y_i}{K_i} \right) \right] = r \left(\frac{1 + \tau_{K_i}}{1 - \tau_{Y_i}} \right)$$

$$\left(\frac{1 + \tau_{K_i}}{1 - \tau_{Y_i}}\right) = \frac{\alpha \left[\left(\frac{\sigma-1}{\sigma}\right) \left(\frac{P_i Y_i}{K_i}\right) \right]}{r}$$

Thus,

$$\left(\frac{1 + \tau_{K_i}}{1 - \tau_{Y_i}}\right) = \frac{MRPK_i}{r} \quad (7)$$

From equation (7) above, it is possible to obtain a relation for the parameter $(1+\tau_{K_i})/(1-\tau_{Y_i})$, which express the capital distortion normalized by the output distortion. This expression will be useful in the next steps when the conception of contribution of BNDES dispersion is introduced. Note I can use the same procedure to isolate the term $(1/1-\tau_{Y_i})$ and properly calculate it as follows:

$$\frac{1}{1 - \tau_{Y_i}} = (1 - \alpha) \left[\frac{\left(\frac{\sigma-1}{\sigma}\right) \left(\frac{P_i Y_i}{L_i}\right)}{w} \right]$$

These expressions will be very helpful in the calculations of TFPR "revenue productivity" and TFP, by substituting their values in the following equations.

Following from this, I define the revenue productivity for all sectors together as :

$$TFPR = \frac{P Y}{K^\alpha L^{1-\alpha}} \quad (8)$$

where $PY = \sum P_i Y_i$

Given that K and L are summation of all K_i and L_i , we have TFPR as:

$$TFPR = \frac{\sigma}{\sigma - 1} \left\{ \sum_{i=1} \frac{r \left(\frac{1+\tau_{K_i}}{1-\tau_{Y_i}} \right) K_i}{\alpha K} \right\}^\alpha \left\{ \sum_{i=1} \frac{w \left(\frac{1}{1-\tau_{Y_i}} \right) L_i}{1-\alpha L} \right\}^{1-\alpha} \quad (9)$$

where $K = \sum K_i$, and $L = \sum L_i$

Now, let me define the physical productivity in this economy as TFP, which is again for all sectors together. The equation will be:

$$TFP = \frac{Y}{K^\alpha L^{1-\alpha}} \quad (10)$$

It follows from equation (10) that:

$$TFP = \frac{1}{P} \frac{PY}{K^\alpha L^{1-\alpha}}$$

And

$$TFP = \left\{ \sum_{i=1}^M \left(\frac{1}{P} \right)^{\sigma-1} \right\}^{\frac{1}{\sigma-1}} TFPR$$

Thus,

$$TFP = \left\{ \sum_{i=1}^M \left(A_i \frac{TFPR}{TFPR_i} \right)^{\sigma-1} \right\}^{\frac{1}{\sigma-1}} \quad (11)$$

Now, it is plausible to believe these sectors in Brazil (related to industry, commerce and services) are under the effect of different types of distortions, not only BNDES distortion, since many other factors might affect the allocation of resources and productivity, such as infrastructure, ease of doing business, openness to importation of raw materials, tax structure, and others.

Given that, I assume τ_{K_i} represents all distortions affecting sector-level allocation of capital in this economy, which include the BNDES distortion, as well. I also consider that $\tau_{\hat{K}_i}$ represents distortions net of government cheap loans, which means that $\tau_{\hat{K}_i}$ will capture all the distortions except the BNDES specific distortion.

In this model, I assume that the vector of distortions to capital can be divided additively in two parts: distortions net of government subsidized credit and distortions directly affect by this policy, as described in the equation below:

$$\tau_{K_i} = \tau_{\hat{K}_i} + \theta_{bndes_i}$$

$$1 + \tau_{K_i} = 1 + (\tau_{\hat{K}_i} + \theta_{bndes_i})$$

$$1 + \tau_{K_i} \simeq (1 + \tau_{\hat{K}_i}) (1 + \theta_{bndes_i}) \quad (12)$$

where, θ_{bndes_i} is the specific BNDES effective rate that will impact the productivity calculation in the model; and $\tau_{\hat{K}_i}$ is the distortion net of this effect. This approximation uses the assumption that distortions are small and that they can be separated in two terms: distortions net of BNDES effect and the specific BNDES rate.

It is important, from this point on, to set an expression for this distortion, since it will be useful to determine the contribution of BNDES dispersion and the TFP loss associated with that. Combining the expression for $1 + \tau_{K_i} / 1 - \tau_{Y_i}$ in equation (7) with the capital distortion relationship in equation (8) I can state that:

$$\frac{1 + \tau_{K_i}}{1 - \tau_{Y_i}} = \frac{(1 + \tau_{\widehat{K}_i})(1 + \theta_{bndes_i})}{1 - \tau_{Y_i}}$$

Consequently,

$$\frac{1 + \tau_{\widehat{K}_i}}{1 - \tau_{Y_i}} = \frac{\left(\frac{1 + \tau_{K_i}}{1 - \tau_{Y_i}}\right)}{1 + \theta_{bndes_i}} \quad (13)$$

where $1 + \tau_{\widehat{K}_i} / 1 - \tau_{Y_i}$ is the capital distortion net of BNDES effect normalized by the output distortion.

Now, I have all the elements needed to calculate this normalized distortion, knowing that this expression will be used in the calculation of contribution of BNDES dispersion. Since I will just need the expression normalized, or $1 + \tau_{\widehat{K}_i} / 1 - \tau_{Y_i}$, to substitute in the TFPR and TFP equations, I don't need to define a specific expression for τ_{Y_i} .

To calculate the sector-level *effective BNDES rate* I am considering that there is a premium in the subsidized rate over the market rate. Sectors that can benefit from government low-cost loans pay a diminished rate in those borrowing, compared to the rate granted by the market; and in Brazil this difference can be large, as discussed in previous sections of this paper.

I am assuming that all loans received by sectors are used for investments, in a way that the total investment a sector has in a year is the result of the subsidized loans from BNDES plus the loans that are obtained from the private market.

Thus, I will define θ_{bndes_i} as follows:

$$\theta_i = R_{i_{bndes}} \left(\frac{I_{i_{bndes}}}{I_i} \right) + R_{i_{market}} \left(\frac{I_{i_{market}}}{I_i} \right)$$

$$1 + \theta_{bndes_i} = \frac{\theta}{R_{i_{market}}} \quad (14)$$

where $R_{i_{\text{bndes}}}$ is the interest rate sectors have to pay for the BNDES when receiving loans; R_i market is the interest rate levied by the market in a typical credit concession; $I_{i_{\text{bndes}}}/I_i$ measures the loans received from BNDES as a share of total investments and $I_{i_{\text{market}}}/I_i$ measures the loans paid in the market as a share of total investments. I am considering that all credit received from BNDES are used in investments, so the total investment a sector has done in a specific year is the summation of BNDES loans and market loans; when BNDES loans exceed the total investments in a year, I assume the market loans is zero, since all the money used in investments came from BNDES and the surplus was used by the sector in other assets. Since I will compare the effect of a reduction in the interest paid for the BNDES after receiving a loan with the magnitude of BNDES dispersion, and this rate, $R_{i_{\text{bndes}}}$, is unique for all sectors, I am considering an unique market rate in this equation.

Equation (14) is crucial to calculate the BNDES dispersion contribution, since it shows the rate at which the marginal revenue product of capital is reduced for a given sector in the calculation of the TFPR_i . It tells us that the more a sector is dependent on BNDES loans, the lower should be $1 + \theta_{\text{bndes}}$, in a way that if a specific sector in Brazil depends heavily on subsidized loans, this parameter will decrease, having an impact on the TFPR_i .

All the variables now can be calculated with the data I have, so I am ready to establish the relation for the contribution of BNDES dispersion by finding an equation for TFP given all distortions and TFP net of BNDES distortion.

The purpose of this paper is to analyze if the subsidized credit from BNDES are causing productivity distortions in the allocation of resources in Brazilian sectors, which will be more severe if less efficient sectors end up receiving more low-cost loans.

Consequently, I denoted TFP under all types of distortions as $\text{TFP}(\tau_{K_i}, \tau_{Y_i})$ and TFP excluding only the specific distortion caused by BNDES loans as $\text{TFP}(\tau_{\hat{K}_i}, \tau_{Y_i})$.

By doing this distinction I can calculate the TFP contribution of BNDES distortion as a share of all distortions as follows:

$$\frac{TFP(\tau_{\widehat{K}_i}, \tau_{Y_i})}{TFP(\tau_{K_i}, \tau_{Y_i})} - 1 \quad (15)$$

Equation (15) above measures the percentage of the BNDES distortions related to the vectors; It is a percentage relative to the all distortions. If there are no distortions of any kind, then TFP_{Ri} should be equal to TFP_R for every sector(i). Following from this we can say that the efficient TFP is:

$$TFP_{efficient} = \left[\sum_{i=1}^M (A_i)^{\sigma-1} \right]^{\frac{1}{\sigma-1}} \quad (16)$$

The TFP loss caused by distortions in the sectors analyzed will be:

$$\frac{1 - TFP(\tau_{K_i}, \tau_{Y_i})}{TFP_{efficient}} \quad (17)$$

6 Methodology

I explained more detailed how the data obtained fit the proposed model and how the variables are calculated.

Variables in the model:

The data I am using in this paper is from BNDES – Desembolsos por setor CNAE, Pesquisa Industrial Anual (PIA), Pesquisa Anual do Comércio (PAC) e Pesquisa Anual

do Serviço (PAS), as discussed more fully in the data section.

In the model, I am assuming a Cobb Douglas function where Y_i is the value added of each sector that received loans from BNDES in 2014.

K_i is the capital stock for each sector, calculated from the investments and depreciation, by the perpetual method and L_i is the workforce in production for each sector. I am also considering the value of loans received by each sector in the calculation of *effective BNDES loans rate*.

Calibration:

Following Chen (2017) and Hsiew and Klenow (2009) I set the elasticity of substitution $\sigma=3$.

In the model, w and r are exogenous variables. Based on the data from PIA, PAS and PAC mentioned above, I calibrate them to the average effective wage rate of labor and rental rate of physical capital for the sectors analyzed as below:

$$w = \frac{\sum_{i=1}^M Wages_i}{\sum_{i=1}^M L_i}$$

where $Wages_i$ = total salaries per year linked to production for each sector that received loans; and L_i is the workforce (working in production).

$$r = \frac{\sum_{i=1}^M P_i Y_i - Wages_i}{\sum_{i=1}^M K_i}$$

where $P_i Y_i$ is the sector level revenue as value added, K_i is the capital stock for each sector, and $Wages_i$ is the total salaries linked to production.

In this model, Y_i is produced by sectors with Cobb-Douglas production function, so α will be calibrated as the share of output paid to capital. I am considering a first scenario using a calibration that incorporates sector differences in capital intensive characteristics. So, I will calculate a different α for each sector, as follows:

$$\alpha_i = \frac{P_i Y_i - Wages_i}{P_i Y_i}$$

I will also consider an alternative scenario with one single calibration for α taking the summation of added value in this formula and see how my results could change doing this.

Following Hsiew and Klenow (2009), I also set the A_i (physical productivity) as:

$$A_i = \frac{(P_i Y_i)^{\frac{\sigma}{\sigma-1}}}{K_i^\alpha L_i^{1-\alpha}}$$

Steps for calculating TFPR and TFP:

As in Chen (2017), I followed the next steps to calculate the TFP related to all distortions and TFP related to distortions net of BNDES effect and, finally, find the BNDES contribution.

1. Firstly, I use the calibration for r and w to obtain their values.
2. According the calibration of α , I calculate its value.
3. Using the elasticity of substitution $\sigma=3$ and the values for r , w and α I calculate the $MRPK_i$ and $MRPL_i$ in equation (3) and (4).
4. From the results obtained above, I estimate the capital distortion normalized by output distortion ($1 + \tau_{K_i} / 1 - \tau_{Y_i}$), according to the relation in equation (7). Similarly, I calculate the term $1/1 - \tau_{Y_i}$.
5. I estimate the sector-level $TFPR_i$ in equation (6) and $TFPR$ for all sectors together in equation (9) associated with all distortions, using the results I have obtained in the steps above.
6. I calculate A_i from the calibration above, and I use the result to calculate the TFP associated with all types of distortion in equation (11).
7. Now, I do the same calculations, but now considering the expression for capital distortion net of BNDES effect. I calculate the θ_{bndes} in equation (14) and use the result

to calculate the expression $(1 + \tau_{\hat{K}_i} / 1 - \tau_{Y_i})$ from equation (13), which will be useful in the steps below.

8. I do the same procedure from steps 5 and 6, but now using the expression for distortions excluding BNDES $(1 + \tau_{\hat{K}_i} / 1 - \tau_{Y_i})$ instead of all distortions $1 + \tau_{K_i} / 1 - \tau_{Y_i}$ in the equations (6), (9), and (11). The other parameters will remain the same, the only change I need to do to be able to calculate the TFPR and TFP associated with the net effect of BNDES is use the result from equation (13) in this new procedure. Having done all the procedures here, I am ready to use the values of TFP (τ_{K_i}, τ_{Y_i}) associated with all distortions and TFP $(\tau_{\hat{K}_i}, \tau_{Y_i})$ associated only with the net effect of BNDES to calculate the contribution to dispersion.

9. I calculate the contribution of BNDES dispersion to TFP following equation (15).

10. Finally, I calculate $TFP_{\text{efficient}}$ in equation (16) and use the result to calculate TFP loss according to equation (17).

7 Results

Firstly, I analyzed the relationship between the sector-level revenue productivity calculated in equation (6) and the BNDES loans. The premise I want to test is if more productive sectors received proportionally more loans, since the model implicates that a lower τ_{K_i} leads to a lower $TFPR_i$. It is important to do this comparative analysis, since one could argue that even sectors that generate a smaller added value are able to be highly productive in the allocation of labor and capital, resulting in a high productivity.

To explore this possibility, I did the same study relating loans with sector-level $TFPR_i$. I calculate the productivity according to equation (6) and took the logs, as well as with loans. It is noticeable from figure 5 that the dispersion is even greater for this relationship and it seems to have a negative correlation between the two measures (loans and revenue productivity).

The “y” axis is log of $TFPR_i$ by sector and the “x” axis is log of loans received by each

sector. It can be seen that some very productive sectors are receiving less subsidies from the bank than some others, proportionally; while others that performed inferiorly have been granted with more low-interest credit; it is also noticeable there is a great dispersion in this relationship and some outliers. This is a potential initial indicator of distortions and misallocation, since there is no a clear positive correlation between productivity and loans received by sectors.

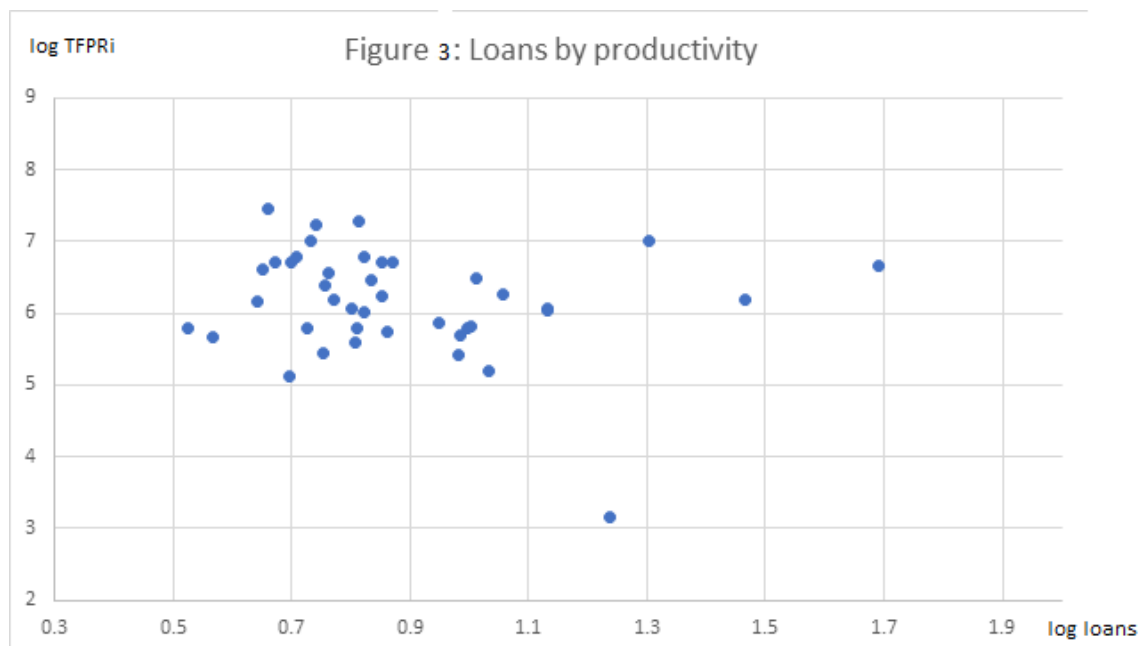


Figure 3: BNDES loans by TFPri of each sector

After exploring these relationships, I have calculated all the equations described in the Methodology section and the main results are presented in table 1.

Row 1 measures the contribution of BNDES dispersion to TFP loss in 2014, based on equation (15). It can be interpreted as the TFP gain, in %, from removing BNDES distortions compared to current actual TFP level, or TFP (τK_i , τY_i), as specified in the model. My findings indicate that the BNDES contribution to TFP loss is about 23.12%, which means that almost a quarter of TFP gain could be obtained, if this specific distortion was removed. It supports the hypothesis that the advantageous interest rates granted by BNDES for some sectors in Brazil is related to resources misallocation.

Along with this estimation, I also calculate the TFP loss by cause of misallocation, based on equation (17) relative to the efficient level. From row 2 it can be seen that 41.31% of TFP in Brazil is lost due to misallocation, according to data. This finding contemplates all types of distortions, as discussed earlier, which means that TFP is around 41% smaller than it would be without any distortions. It is a very telling number, especially in an economy that has been adopting active development policies, which could be an indication that some of these policies are not effective in focusing on productivity to increase GDP.

Table 1: estimation of BNDES dispersion for 2014

Results	2014	$\alpha=0.64$	$\sigma=2$
BNDES contribution (%)	23.12	19.06	30.50
TFP loss (%)	41.31	32.58	47.66
TFP loss net of BNDES (%)	27.37	11.02	29.34

Row 3 brings the results for TFP loss net of BNDES, which is interpreted as TFP loss caused by all the distortions except from BNDES. It is measured following equation (15), but considering TFP net of BNDES in the formula, as $1 - \text{TFP}(\tau\hat{K}_i, \tau Y_i) / \text{TFP efficient}$. It tells us that 27.37% of TFP is lost due to distortions except the specific BNDES effect.

Beyond that, I considered 2 other possible scenarios, presented in columns 2 and 3. My first results were obtained considering different alphas for each sector, since they are very divergent in their characteristics. As discussed earlier, some sectors in this database are highly capital intensive, such oil and gas or chemicals, while others, like education or cultural activities, are not. Because of this fact, I considered a specific α calibration for each sector.

Column 2 shows the same analysis, but now considering an alternative scenario, where α is the same for every sector, based on an analogous calibration to the one discussed above. In this case, the α would be 0.64 and the results changed slightly: the contribution

of BNDES dispersion to TFP loss, based on equation (15) is now 19%, smaller than the previous result, and the TFP loss caused by all distortions, based on equation (17) is also smaller, about 32%. I also calculated the TFP loss net of BNDES, representing how much of the TFP is lost due to distortions except from BNDES, and the results indicate a measure of 11%. This result suggests that the fact of taking into account the characteristics of each sector has a great influence on the overall results. Ignoring that some sectors are more capital intensive than others may lead to misinterpretation of the BNDES dispersion contribution to TFP loss in the economy.

Likewise, I tested an alternative scenario for the CES technology. Firstly, I considered $\sigma = 3$, following Hsieh and Klenow (2009) calibration, but in column 3 I run the same exercise considering now $\sigma = 2$. It can be seen that the results changed more considerably in this scenario. The contribution of BNDES dispersion to TFP loss under this circumstance is now 30.5%, a higher measure than the other tested scenarios; and the TFP loss caused by all distortions is around 47%. The TFP loss net of BNDES dispersion is now about 29%. Again, it is clear that the calibration of parameters influences the final result, which can lead to different interpretations.

The results obtained so far are based on the year of 2014, which is the last year with public data on BNDES loans. As 2014 was a year of political campaign and election, configuring the last term of the president in force in the mandate, I run a new exercise considering other years also in the analysis. The idea that motivated these new calculations was the fact that, as a political transition year, this could have had an impact on the volume of BNDES loans and on market interest rates. Therefore, I considered another 3 years base in the calculations: 2003, 2008 and 2011, none of them was a election year, to see how the results could change. They were also marked by different political and economic events, both domestic and foreign.

Table 2 shows the results for these years, considering the same calculation exercise. 2003 was a year of political change in Brazil, Lula da Silva from PT was elected president for the first time in his long career as politician and activist. He had a much more social platform, focusing on fight against inequality in the country. It was a year of BNDES consolidation, but especially a year of economic uncertainty and turbulence, oscillation

in the financial market and, consequently, interest rates increased in this period. The reference rate (SELIC) was well above the historical average, and even TJLP, the BNDES loan rate, was also well above the current levels.

To analyze how this political and economic scenario can impact the results of equations (6), (9) and (11) and, consequently, the TFP loss from all distortions in equation (17) and the BNDES contribution to TFP loss in equation (15) from the model. I did the same exercise, but now with data for all variables measured in those years (2003, 2008 and 2011).

Table 2: new scenarios: data for 2003, 2008 and 2011

Results	2003	2008	2011	average
BNDES contribution (%)	14.10	18.28	31.90	21.40
TFP loss (%)	45.30	28.03	33.26	35.60

The results from row 1 indicate that the contribution of BNDES dispersion to TFP loss was 14.10% in 2003, which is lower than the result for my base-year (2014). This indicates that removing the BNDES distortions implicates in around 14% of TFP gain compared to the TFP (τK_i , τY_i) level for 2003. The TFP loss caused by all distortions in 2003 is 45.30%, lower than the result for 2014.

2008 was a political consolidation year for Lula da Silva, following his second mandate in the presidency. This year was marked by the beginning of a global financial crisis, which had several negative economic consequences worldwide. During this period, the Brazilian government started to use BNDES more heavily as an anticyclical instrument to overcome the effects of the crisis. It was a year in which rates for BNDES loans were reduced and lending volumes were increased. To test the effect of this new scenario, I did all the calculation using data for 2008 and row 2 brings the results. It can be seen that the BNDES contribution was about 18%, more than it was in 2003, but also lower than

my base-year (2014). The TFP loss from all distortions is around 28% in 2008, the lowest result for this measure compared to previous calculations.

Finally, 2011 was marked by the election of President Dilma Rousseff, also from PT, and the beginning of her term in the presidency. It was a year of economic growth, marked by a decline in unemployment rates, accelerated economic growth, stable inflation and lower interest rate. Also, the subsidized rates, TJLP, were reduced in this period, falling to lowest historic levels so far. Because SELIC was higher than it used to be in previous year, the difference between these two rates was especially higher in 2011. In this period, BNDES increased even more the volume of loans compared to previous years, consolidating the development bank as an important policy instrument for the government. Row 3 brings the results for 2011, it can be noticed that the BNDES contribution to TFP loss was almost 32%, much higher than previous years and also higher than my base-year (2014), which supports the hypothesis that the difference between subsidized low-interest rate and private market rate has an important role in the measurement of misallocation in this model. Periods when this difference was higher also led to a greater BNDES contribution to TFP loss. TFP loss from all distortions was 33.26% in 2011, a result that not differs greatly from 2014.

The column 4 shows the average result for the three-year calculations. It can be seen that the contribution of BNDES dispersion to TFP loss was 21.40% in average, which means that the TFP potential gain from removing BNDES distortions compared to $TFP(\tau K_i, \tau Y_i)$ levels is around one fifth, in average, during these years. Also, the TFP loss from all distortions was 35.60%, in average, which means that TFP was one third smaller, on average, than it would be without any distortions in these years.

I amend my quantitative analysis addressing some recent discussion about the BNDES loans rates and how it could modify my empirical results. In 2017, due to the economic crisis experienced by Brazil, some proposals for readjustment and balance of public budget have been debated; among them the alteration of BNDES loans rate. Consequently, I did a quantitative exercise to consider another possibility for my results, trying to calculate how should be the expected impact on TFP gains and BNDES contribution to dispersion if this change really happens.

To contextualize the exercise taking into account this proposal, it is necessary to briefly discuss how large this rate change would be. The provisional measure discussed in the Brazilian Senate aims to replace the current rate with a new one, called TLP (Taxa de Longo Prazo, or Long-Term interest rate, in English) - Long Term Rate. This rate would then be the reference for BNDES subsidized loans and would be calculated based on the variation of a public bond linked to the yearly inflation, which had not previously occurred. By doing this, loan conditions granted by the National Bank would approximate market practices and be anchored to inflation variation. Furthermore, it would bring the interest rate on loans closer to the country's official interest rate. The Brazilian government expects to reduce subsidy spending due to the difference between the rate paid by the National Treasury and the lower rate charged by BNDES on loans. The estimation is that the new rate would jump from 7% per year to around 9.5% per year, which would diminish the gap between market rate and make loans less costly to the Treasury.

I adjust my calculations to this new possibility by exploiting how the results could change with this increase in the new BNDES rate, considering again just the data from 2014. Therefore, I retake the estimation of equation (14) using a new BNDES rate of 9.5%, instead of 7%, based on this new premise. Consequently, I also retake the estimation for equations (15) and (17) and found a new TFP loss linked to the BNDES distortions. The results are described in Table 3.

Table 3: new TLP rate and its impact on BNDES contribution - 2014

Results	New TLP
BNDES contribution (%)	11.93
TFP loss (%)	41.31
TFP loss net of BNDES (%)	34.32

From row 1 in Table 3 can be noticed that this new proposal could potentially reduce

the contribution of BNDES dispersion to TFP loss. The results changed from 23.12% in the first scenario (2014) to 11.93% with the new TLP for the same year, a lower contribution. This result means that, if this proposal is accepted, this would result in a 51% reduction in BNDES contribution to TFP loss, suggesting that the discrepancy between public bank loans rates and private market rates has a significant impact in the result and is a source of resources misallocation. Considering the current level of SELIC and the new TLP proposal, the difference between the two rates would be approximately 4 percentage points, and by increasing TLP to be closer to SELIC interest rate, misallocation due to BNDES could be reduced. This indicates there is room for adaptation of the credit promotion policies in Brazil and reduction of resources misallocation by taking a more realistic measure for BNDES loans rate. It would be an initial step for the government to get closer to the goal of increase the Brazilian productivity. The TFP loss from all distortions have not changed, since this new BNDES rate will impact only the TFP associated with distortions net of BNDES, the TFP from all distortions remains unchanged in this exercise. On the other hand, the TFP loss net of BNDES have changed and is now 34.32%, which is expected, since the contribution of BNDES for TFP loss has decreased and TFP from all distortions has remained the same.

8 Conclusion

The topic of misallocation has been largely studied and debated in economics using various methodologies. A long stream of papers has pointed how deleterious misallocation and allocative distortions could be for productivity. In this paper I took a direct approach, where I investigated misallocation in the Brazilian economy with a directly measurable BNDES distortion. Using data on productive sectors in Brazil (2003 – 2014) and subsidized loans received from BNDES for the same period, I adopted a monopolistic competition model of Hsieh and Klenow (2009) to estimate the Chen (2017) version of the contribution of BNDES to these distortions. The goal of this paper was to directly calculate the contribution of BNDES distortions to TFP loss, using the fact that the large difference between

public loans rates and private banks rates in Brazil is a potential source of resources misallocation. I found that BNDES dispersion has a contribution of 23.12% in TFP loss compared to current levels for 2014 and, therefore, TFP is 23.12% lower than where it would be in the absence of the specific distortion. Another important result is the TFP loss in Brazil, as a response of distortions. The paper concludes that around 41% of the Brazilian productivity is lost, which is a expressive number, indicating Brazil still has a long way to improve its productivity and, consequently, economic growth. I also exploited different scenarios, considering a variation in the calibration for α and σ , and results indicate that the way parameters are calibrated have an impact on the final result. With a single α for all sectors, the contribution of BNDES dispersion to TFP loss was reduced to around 19% and TFP loss due to all distortions was reduced to around 32%. Likewise, with a new value of $\sigma=2$, the results also changed, but more intensively. The BNDES contribution to TFP loss was increased to about 30% and TFP loss from all distortions jumped to around 47%. Similarly, I considered 3 more years in my analysis (2003, 2008 and 2011) to see how the results could change facing different economic and political contexts. The calculations suggest that years with a large differences between BNDES rates and private market rates are associated with a greater BNDES contribution to TFP loss. In 2003, the contribution of BNDES dispersion was around 14% and TFP loss from all distortions was around 45%. In 2008, the BNDES contribution was slightly higher, about 18%, while TFP loss was about 28%. The BNDES contribution was the highest in 2011, reaching 32%, almost twice as high as previous years, and it was the year when the difference between the two rates started to increase more significantly. The TFP loss in 2011 was around 33%.

Additionally, I did the same calculations considering a possible alteration in the BNDES rate, following the recent proposal discussion in Brazil. By diminishing the gap between BNDES loans rate and market rates, the contribution of BNDES dispersion falls to around 12%, which means that bringing the BNDES rate closer to market interest rates, it would be translated in a reduction of 51% in BNDES contribution to TFP loss, indicating the difference between the rates is one important aspect of the result and possibly one key feature the Brazilian government should address in order to reduce misallocation

in BNDES policy. The TFP loss remained unchanged with this new scenario.

References

- [1] Acervo do Centro de Pesquisas de Informacoes e Dados, (2012) "BNDES: um banco de historia e de futuro". *Museu da Pessoa: Colecao de depoimentos, Projeto Memorias 60 anos BNDES*.
- [2] Alfaro, L., Charlton, A., Kanczuk, F., (2008) "Plant-size distribution and cross-country income differences?". *NBER Working paper N. 14060*.
- [3] Buera, F.J., Moll, B., Shin, Y., (2012) "Well-intended policies". *Review of Economic Dynamics*. 16, 216-230.
- [4] Chen, S.X.G., (2017) "VAT rate dispersion and TDP loss in China's manufacturing sector". *Economic Letters: Elsevier*. 155, 49-54.
- [5] De Bolle, M., (2015) "Do public development banks hurt growth? Evidence from Brazil". *Peterson Institute for International Economics*. PB15-16, 1-15.
- [6] Elstrodt, H., P., Manyika, J., Remes, J., Ellen, P., Martins, C., (2014) "Brazil's path to inclusive growth". *McKinsey Global Institute*.
- [7] Fajgelbaum, P.D., Morales, E., Serrato, J.C.S., Zidar, O.M., (2016) "State Taxes and Spatial Misallocation". *NBER Working Paper N.21760*.
- [8] Gao, H., (2013) "Factor market distortion in China's manufacturing industry". *University of Leuven*. 104 (10), 3186-3221.
- [9] Guner, N., Ventura, G., Xu, Y., (2008) "Macroeconomic implications of size-dependent policies". *Review of Economic Dynamics*. v11, 721-744.
- [10] Hsieh, C.T., Klenow, P.J., (2009) "Misallocation and manufacturing TFP in China and India". *The Quarterly Journal of Economics*. 124 (4), 1403-1448.

- [11] Khwaja, A., I., Mian, A., (2005) "Do lenders favor politically connected firms? rent provision in an emerging financial market?". *The Quarterly Journal of Economics*. 104 (10), 1371-1411.
- [12] Kuwer, F., S., (2016) "Earmarked credit and misallocation: evidence from Brazil"., Master's Dissertation *Faculty of Economics, Administration and Accounting, University of Sao Paulo*. PB15-16, 1-15.
- [13] Lileeva, A., Treffer, D., (2010) "Improved access to foreign markets raises plant-level productivity for some plants". *The Quarterly Journal of Economics*. v125, 1051-1099.
- [14] Midrigan, V., Xu, D.Y., (2014) "Finance and misallocation: Evidence from plant-level data". *American Economic Review*. 104 (2), 422-458.
- [15] Moll, B., (2014) "Productivity losses from financial frictions: Can self-financing undo capital misallocation?". *American Economic Review*. 104 (10), 3186-3221.
- [16] Ordonez, J., C., L., (2014) "Tax collection, the informal sector, and productivity". *Review of Economic Dynamics*. v17, 262-286.
- [17] Pavenik, N., (2002) "Trade liberalization, exit, and productivity improvements: evidence from Chilean plants". *Review of Economic Studies*. v69, 245-276.
- [18] Restuccia, D., Rogerson, R., (2008) "Policy distortions and aggregate productivity with heterogeneous plants". *Review of Economic Dynamics*. 11, 707-720.