# Essays on Credit Markets and on Information

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# Abstract

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In the first chapter of my thesis, titled "Interventions in Credit Markets and Effects on Economic Activity: Evidence from Brazil," I investigate the impact of the Brazilian government policy implemented in March 2012, which aimed at increasing credit supply through public banks. Using bank branch level data, I find that the policy successfully increased overall credit supply, as increased lending of public banks did not significantly offset private lending. On the other hand, there is no evidence of significant client-switching between private and public banks. However, the effects of the policy on economic activity were limited and even negligible. I conduct a series of robustness checks to further explore this puzzling result. I find evidence suggesting that increased lending led to significant increases in deposits, indicating that borrowers leveraged easily accessible credit to take loans and save funds for future use.

In the second chapter, titled "Television Introduction and Agricultural Production," I investigate how improved information affected agricultural activity in the U.S. Specifically, I argue that the introduction of television brings more comprehensible weather forecast information to farmers, improving their decision making process. Using data about television entry and county level farming production in a difference-in-differences methodology, I estimate economically significant effect of television introduction on crop yields.

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# Introduction

First chapter of my thesis, titled "Interventions in Credit Markets and Effects on Economic Activity: Evidence from Brazil," investigates effects of government interventions in credit markets. More precisely, I study a Brazilian government policy from March 2012 aimed at increasing credit supply to households and firms. Specifically, I explore how this policy affected competition in the banking sector and real outcomes in the economy.

Banking sector in Brazil is characterized by presence of both public (state-owned) and private banks. Public banks are occasionally used as a government tool to enhance financial development of underdeveloped areas or to carry out credit policies. The policy that I study provides a clean setting to understand effects of government intervention on economic activity because it was not introduced as a response to an impending crisis. To keep the analysis clean of other shocks that could affect outcomes of interest, I constrain the analysis to the period 2011-2013.

I use branch level balance sheet data to obtain information about bank lending activity and deposits. I merge this data with the data about municipality level GDP and employment when I examine the effects of the policy on real economic outcomes.

The first set of results provides evidence that the policy was successful in increasing overall credit supply in the economy. I document that public banks adhered to the policy and substantially increased lending. Moreover, I do not find evidence that this behavior of public banks crowds-out private lending.

Next, I find no evidence that the policy intensified competition for customers between public and private banks. I use information about deposits as a proxy for the size of a bank's customer base. I

find no relationship between increased lending activity of public banks and the size of deposit accounts of private banks suggesting that clients do not significantly switch banks after the policy. The third set of results show that the effects of the increase in total lending on economic activity were virtually zero. Specifically, I do not observe a response neither in GDP nor in (formal) employment as a result of the significant increase in total lending. To validate this puzzling result, I run a series of robustness checks confirming these findings - irrespective of whether I look at municipalities that are "monopolized" by particular type of banks (public or private), or I aggregate the analysis to the higher geographical level to account for potential spillover effects in economic activity across neighboring municipalities, I find no evidence that the policy affected real outcomes in the economy.

Finally, I estimate a significant increase in deposit creation in a response to the policy that expanded credit supply. This provides suggestive evidence that borrowers, both households and firms, used increased availability and accessibility of funds to take loans and save a significant portion of them for future use. This opens up the possibility for future research with more detailed data. For example, it would be interesting to understand if there are structural differences between clients of public and private banks.

This paper contributes to the literature discussing government interventions in credit markets. There are opposing views in this literature. On one side, there is evidence that credit supply increases through public banks can have positive real effects and generate crowding-in of private lending. On the other hand, some authors argue that the real effects of government interventions are very limited and usually result in negative outcomes such as increases in households' debt burden. My paper sides with the latter, providing novel evidence that government interventions in credit markets might not be a useful tool in reaching economic growth. Additionally, this paper contributes to further understanding of competitive forces in the Brazilian banking sector and competition between public and private banks in general.

In the second chapter, titled "Television Introduction and Agricultural Production," I investigate how improved information affected agricultural activity in the U.S. Specifically, I argue that the

introduction of television brings more comprehensible weather forecast information to farmers, improving their decision making which, in turn, enhances crop yields.

Information about the weather significantly influences farming decisions such as when to plant, whether and how much to irrigate, when to apply pesticide, etc. Shifting these actions for a couple of days due to weather conditions can result in a substantial impact on crop yields. Therefore, any improvement in information is valuable to farmers, who need to make these decisions quickly and in an imperfect information setting. For this reason, I argue that the introduction of television presents an improvement in farmers' information set, as it allowed for visual presentation of expected weather conditions which is easier to comprehend.

In the data, I use county as a unit of observation. On one hand, I use data on television introduction which allows me to observe when the broadcasting signal reached the county, and observe the diffusion of television within the county. On the other hand, I collected data on agricultural activity from the U.S. Agricultural Censuses. Specifically, I collected data on corn yields, acreage planted with corn, and the number of farms within the county.

I use staggered difference-in-difference approach to estimate the effect of television introduction on agricultural activity. My identification strategy relies on differences between counties with respect to the timing of television entry. Essentially, I am comparing nearby counties that are exposed to similar weather conditions and soil quality, but experienced television entry at different times, to understand the effects the introduction of television had on agricultural outcomes. A potential concern in taking this approach is that the treatment is endogenous to agricultural activity. However, I argue that this is not the case. Television was introduced for reasons other than agricultural production. FCC, as a government agency, allocated broadcasting licenses in a way to maximize the number of viewers reached by the television signal. On the other hand, TV stations applied for broadcasting licenses in areas that promised the highest expected revenue from advertising. Once they started broadcasting, the signal reached surrounding rural areas as well.

I estimate a significant effect of the introduction of television on corn yields. The results are

robust to alternative definitions of the treatment variable that account for the diffusion of television within a county. Moreover, the results show a similar pattern when considering counties from "corn states" (states that are largest producers of corn in the United States).
This paper contributes to the literature estimating effects of television introduction on various dimensions, ranging from involvement in political life, over children's cognitive development, to circulation and revenues of newspapers. On the other hand, this paper contributes to the literature estimating the value of weather information for farming decisions.

# Chapter 1: Interventions in Credit Markets and Effects on Economic Activity: Evidence from Brazil

## 1.1 Introduction

Governments sometimes try to stimulate the economy by pushing banks to increase their lending. I study this question from the perspective of an unexpected policy announced by the Brazilian government in March 2012. This policy had the objective of expanding credit supply across the Brazilian economy via public banks.[1] This setup provides a clear context to understand effects such intervention can have on the economy and competition within the banking sector, as the policy did not coincide with an impending crisis, eliminating other external shocks that could influence the outcomes of interest. The policy was motivated by the gradual fall of commodity prices in 2011, which might have led to an economic slowdown.[2]

In an initial set of results, employing the data set containing balance sheet information on individual branches of Brazilian banks, I document that public banks adhered to the intervention and increased their credit supply. Looking at trends in loan origination, I observe substantial increases in loan amounts across all broadly defined loan categories for public banks. Specifically, *Caixa Economica Federal* (CEF) drives the increase in personal credit and mortgages, while *Banco do Brasil* (BB) increases the supply of agricultural loans. Moreover, both banks contribute to the tripling of investment loans in the period after March 2012.

My next set of results examines the response of private banks to the increased lending activity of public banks. The concern is that public banks issued loans to households and firms that would

[1] Throughout the paper, I use terms like *government banks*, *state-owned banks*, and *public banks* interchangeably. These terms refer to banks that are owned by the government, either entirely or the government being the major shareholder if a bank is publicly listed. Brazilian government uses these banks to extend lending to firms and households directly. Banks whose majority shareholder is not the Brazilian government I refer to as *private banks*.

[2] High commodity prices had sustained the Brazilian economy during the Great Recession.

have otherwise been issued by their private competitors. Utilizing fixed-effects regression analysis where I regress newly originated loans of private banks on loans issued by public banks, I do not find evidence that increases in public bank lending were significantly offset by decreased lending activity of private banks.

In addition to testing for evidence of crowding-out, I also discuss how the policy affected competition in the Brazilian banking market. Specifically, I examine bank competition over clients. To gauge this, I utilize data on deposits from individual bank branch balance sheets to construct a proxy for the size of bank's clientele. For instance, if an individual takes a mortgage with CEF, one might expect her to also switch her checking account to CEF. Using fixed-effects regressions, I find no evidence of significant client-switching from private to public banks.

Having established that government intervention substantially increased credit supply in the economy, my next set of results examines whether this influx of additional funds had an effect on economic activity. To conduct this analysis, I merge the data set containing information on bank loans with the data on municipality-level GDP and formal employment.[3] To estimate effects, I run a series of panel data regressions, regressing logarithms of GDP and employment on the logarithm of total lending. However, a significant threat to identification is that total lending is endogenous. Namely, in the data, I observe only equilibrium outcomes in the credit markets. Therefore, this variable encompasses both information on credit supply and credit demand. I address this issue in two ways. First, I include variables intended to control for changes in credit demand, such as government transfers to municipalities and average municipality payroll. Despite these inclusions, potential unobserved heterogeneity across municipalities may bias the estimates. To account for this, I adopt a second approach, in which I construct a control variable that captures the portion of increase in total lending attributable to credit demand. I then estimate the coefficient of interest, incorporating this synthetic control variable in the regression, and assuming that the presence of this control variable in the main regression orthogonalizes total lending from the error term.[4] These

[3]Municipality-level GDP data is coming from the Brazilian Institute of Geography and Statistics (IBGE). Employment data is coming from Annual Review of Social Information (RAIS), and is compiled from annual reports that have to be filed by companies and covers formal employment.

[4]For this approach, I follow the estimation procedure suggested by Imbens and Newey (2009), which uses an

two approaches yield very similar results, indicating that the effect of government intervention on economic activity was negligible in the short term.

I run a series of robustness checks intended to shed some light on the puzzling result that such a substantial increase in credit supply had virtually no impact on economic activity. First, I narrow the analysis to a subset of municipalities that have access to only one type of bank, either public or private. While the effect is twice as large compared to the analysis of the whole sample, it remains economically insignificant. Second, I explore the possibility that the effect is not visible at the very local level, but manifests only at the level of economically integrated municipalities. For example, it could be that people who took personal loans might have spent them outside of the municipality where loans were taken, say, by visiting a shopping mall in a municipality nearby, leading to spillover effects. To account for this, I conduct the analysis at a higher level of geographical aggregation.[5] Even at these levels of geographical aggregation, there is no evidence that increased lending had a significant effect on economic activity in the formal sector. Third, I delve into the effects within individual sectors of the economy. For example, it is very unlikely that a person travels to a different municipality to have a haircut, and thus focusing on the services sector can provide additional evidence that the increase in lending had an effect at the local level. However, I still do not find a significant, measurable effect. This confirms that the policy, while effective in increasing credit supply, had a negligible impact on economic outcomes.

Finally, I explore the possibility that borrowers saved the portion of increased lending in their deposit accounts. Surprisingly, running fixed-effects regressions of deposits on total lending, I find that a significant portion of loans ended up in deposit accounts. Specifically, R$230 out of a R$1,000 loan found its way into deposit accounts, suggesting that households and firms took loans at the time of their high availability and saved the funds for future use. This means that the effects of the policy on economic activity are likely spread over a longer time horizon.

**Literature review.** This paper contributes to the strand of the literature analyzing Brazilian

instrumental variable estimation to construct a synthetic control variable.

[5] I use definitions of micro- and meso-regions as provided by IBGE.

banking sector and competition between public and private banks in general. Sanches et al. (2018) examine what are the effects of privatization on bank presence in small and isolated markets in Brazil. Their main finding is that privatization negatively affects access to banks in small markets. Moreover, they document complementarities between public and private credit, especially between mortgages issued by public banks and private bank lending. In contrast to their results, I do not estimate a significant relationship between public and private credit. Fonseca et al. (2022) study how financial development affects economic activity and wage inequality, using the government intervention in Brazil from the beginning of the century aimed at providing access to banking services in small municipalities as a quasi-experiment. They find that bank entry, in municipalities that previously had no bank presence, fosters economic growth, but these benefits are not shared equally in the population. Even though the focus of my paper is not on this type of financial development, I also observe bank entry in markets that did not have access to financial institutions.[6] I estimate substantially smaller effects on economic activity.[7] Finally, my results complement the evidence in Coelho et al. (2013) who suggest that presence of public banks in a municipality does not affect conduct of their private competitors. Sapienza (2004) documents that public and private banks target different clients, which is in line with my findings that the competition over bank's clientele does not intensify after the introduction of the policy.

Moreover, this paper complements the literature that empirically analyzes government interventions in credit markets. Joaquim et al. (2023) study the same government intervention as I do, using the credit registry data and concentrating on a very particular type of lending - working capital loans. Their main findings are that increased lending led to increased rates of default on debt, with very limited benefits on employment at the firm level, but a larger effect at the regional level. Moreover, they find that the competition between public and private banks in terms of interest rates they charge intensifies as a consequence of the policy. While my results regarding the effects on economic activity complement theirs, I do not find that the policy affects competition

[6]Fonseca et al. (2022) consider the effects of the Brazilian government "Bank for all" program from 2000s, leading to large scale entry of banks into new markets. On the other hand, I consider the period 2011-2013 in my paper.

[7]Results are presented in Appendix A.4.

between public and private banks over customers. Bazzi et al. (2023) find that the credit supply expansion in Brazil led to a greater firm turnover with no short-term effects on growth of formal employment. My results complement the finding that the expansion of credit supply had very limited effects on short-run employment in Brazil. Garber et al. (2021) showed that the same government intervention led to a substantial increase in households' debt burden. They argue that this is evidence of "consumption binging" - households over-borrow in response to a credit expansion. My results reconcile with this view as I estimate a significant relationship between credit increase and deposit growth. Moreover, Schmitz (2020) finds that the government's intervention expanding credit in Brazil significantly impacted credit allocation to SMEs. Studying a different intervention of a small, new credit facility of a Spanish state-owned bank during the crisis, Jimenez et al. (2019) document that the supply of public credit causes large positive real effects to financially-constrained firms as well as crowding-in of new private bank credit.

The rest of the paper is organized as follows. In Section 2, I describe the data I am using in this study. Section 3 describes characteristics and facts about Brazilian banking sector, and provides an overview of the government intervention. In Section 4, I present the empirical strategy and threats to identification. Section 5 presents trends in loan origination, and discusses competition between public and private banks. In section 6, I discuss the effects the policy had on economic activity, while section 7 contains robustness checks for these results. In Section 8, I present results of the analysis of the response of deposits to increased lending, and argue why this is a plausible explanation for absence of significant economic effects. Finally, Section 9 concludes.

## 1.2 Data

My research leverages multiple publicly available data sets coming from various sources. The primary data set for my analysis comprises branch level balance sheets. In order to study the impact on economic activity, I merge this data with data sets containing information about GDP, employment, and payroll. Additionally, I complement these data with other publicly available information allowing me to track government transfers, agricultural activity, population and informal

employment as outlined below.

The branch level balance sheet data is a publicly available data set coming from the Monthly Bank Statistics by Municipality (ESTBAN). This data set provides detailed information on the assets and liabilities of individual branches across all Brazilian banks at a monthly frequency. On the asset side, the data set distinguishes different loan categories: personal loans, investment loans, agricultural loans, mortgages, and other loans.[8,9] In the analysis, I leverage this loan categorization to explore potential complementarities between different loan types and understand how specific loan categories affect particular sectors of the economy. Additionally, I aggregate this data to obtain total lending, which I use in estimating the effects of changes in total lending on economic activity. Regarding liabilities, the data set distinguishes between different deposit types, such as checking accounts, savings accounts, term deposits, and interbank deposits. Due to the unavailability of a more granular data set that would allow me to track bank's clientele, I use deposit information as a proxy for the size of bank's customer base.[10] Additionally, the ESTBAN data identifies the municipality of each branch and, given its panel structure, enables me to track entry and exit patterns of each bank/branch in each municipality in Brazil.

To assess the real effects of the government policy, I match the bank lending data with two additional data sets. The first data set is coming from the Brazilian Institute of Geography and Statistics (IBGE), containing information on the gross domestic product (GDP) at the municipality level at an annual frequency. It encompasses details not only about the total GDP but also about the value added across different economic sectors (industry, services, agriculture, and public administration). The second data set comes from the Annual Review of Social Information (RAIS). This data set provides details about total employment and average wage in the formal sector, and breaks down this information across agriculture, construction, tradable, non-tradable, and all other sec-

[8]The data set distinguishes between farming and livestock loans. However, I define agricultural loans as a single category, aggregating over these two types of loans.

[9]The data set provides information on loans as a stock variable. As part of the analysis that I conduct relates to loan origination, I take the first difference of the data to obtain amounts of new loans that were issued in each month. In spite of using the term "new loans", this number could be both positive (if the amount of newly issued loans exceeds the amount of returned loans) or negative (in the opposite case),

[10]For example, I consider that significant decreases in the amounts of checking deposits suggest that customers are switching away from a bank to another bank where they will start receiving their wages.

tors.[11] I merge this data to branch level balance sheets utilizing the unique municipality identifiers in these data sets.[12]

Throughout the paper, I use additional publicly available data sets containing information about government transfers to municipalities, agricultural production, population, and surveys providing measures of (informal) employment. Constitutional Transfers to Municipalities is a data set from The Transparent Treasury, providing information about government transfers to municipalities at a monthly frequency.[13] For the analysis, I consider only total transfers to municipalities, although the data set distinguishes between several different types of transfers made by the government. Data on agricultural activity is coming from the Municipal Agricultural Production (PAM), which is a nationwide survey conducted by IBGE. It supplies various details on agricultural production, including the average quantity and monetary value of output at an annual frequency, which I utilize in the analysis. Population estimates are provided for each year at the municipality level by IBGE. In order to conduct the analysis at a level of geographic aggregation other than the municipality level, I employ the administrative division of municipalities into micro- and meso-regions, as provided by IBGE. Finally, the National Household Survey (PNAD) offers detailed information on various outcomes for Brazilian households, including their declared participation in the labor force and employment. I use this information to construct a measure of employment in the informal economy by contrasting it with the formal employment data from RAIS.

### 1.3 Brazilian Banking Sector

Brazilian banking sector is quite large, with 151 distinct banks operating across 3,701 municipalities in the period 2008-2018. There are several important characteristics about Brazilian

[11] RAIS covers the entire universe of tax-registered firms in Brazil. This data set is constructed based on annual reports that have to be filed by companies and includes detailed information on their payroll and headcount. Firms face severe penalties that for filing late and/or incomplete information, leading to a high degree of compliance with this requirement. Thus, this data set essentially provides a complete coverage of employment and wages in the formal sector in Brazil.

[12] IBGE provides the unique municipality identifiers for all municipalities in Brazil. These are used across all data sets that I am utilizing in my analysis.

[13] The Transparent Treasury is a portal through which information generated and consolidated by the National Treasury of Brazil is made publicly available.

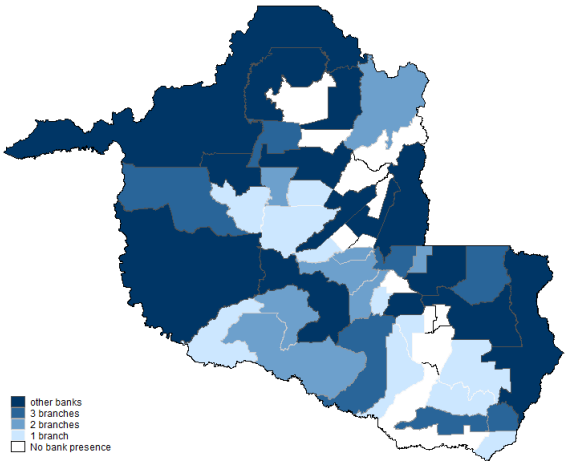



Figure 1.1: Bank presence - Rondônia

Notes: The map presents municipalities comprising the state of Rondônia, which lies to the northwest of Brazil, bordering Bolivia. There is a substantial number of municipalities within the state having access to only 1, 2 or 3 bank branches. Only the largest municipalities have access to more banks. Municipalities in white do not have access to banking services.

banking market that need to be pointed out. First, Brazilian banks can be separated into public (state-owned) banks and private banks. In addition to competing in providing financial services to households and firms, there are some fundamental differences between them. Public banks are legally mandated to provide services to market segments that are not necessarily profitable for private banks, like agriculture sector loans provided by *Banco do Brasil* (BB) or real estate loans by *Caixa Economica Federal* (CEF). These banks could be used by the Brazilian government as an instrument to promote and implement various policies.[14] These public banks can be located in small and isolated markets, sometimes being the only institution providing financial services to households and firms in such markets. In those cases, they can serve as the government's tool to promote banking services in underdeveloped municipalities where it could be difficult for a bank to operate profitably.

Second, there is significant heterogeneity among municipalities in terms of the development of the banking sector. Some municipalities are quite large, with various banks operating with many branches in them. Other are substantially smaller, having access to only a few branches of a limited number of banks. Certain municipalities have access to just a single branch of only one

[14]For example, Coleman and Feler (2015) document how Brazilian government used public banks in a counter-cyclical manner during the 2008-2009 crisis.

bank. There is also a substantial portion of municipalities lacking access to banking services.[15] In the early 2000s, the Brazilian government implemented a policy aimed at expanding access to banking services in many more municipalities across the country.[16] Despite this policy promoting entry of banks into new markets, a substantial amount of bank entry continued in later years.[17] This high heterogeneity in the presence of banks within a municipality is evident across every state in Brazil. Figure 1.1 illustrates bank presence across municipalities in the state of Rondonia, situated next to the Bolivian border in the northwest. Municipalities exhibit significant heterogeneity in terms of the development of the banking sector, with most of them having access to 1, 2, or 3 bank branches. Some municipalities within the state have access to numerous branches of multiple banks, while other have no access to banking services at all.

Third, despite the presence of numerous banks competing in the Brazilian banking sector, the market is dominated by only a few of them. Specifically, according to the number of operating branches in March 2012, more than 85% of the market is controlled by the five largest banks. These major players are *Banco do Brasil* (public bank; market share 24.63%), *Banco Bradesco* (private bank; 21.58%), *Itau Unibanco* (private bank; 17.90%), *Banco Santander* (private bank; 11.76%), and *Caixa Economica Federal* (public bank; 10.97%). I constrain the analysis to the subset of municipalities where only these five largest banks operate. This means that my sample includes municipalities in which all of these five banks operate, as well as those where only some of them have operating branches, or even those monopolized by a single bank among these five.

Fourth, certain banks specialize in issuing particular types of loans. For example, BB issues a substantial number/amount of agricultural loans (in addition to personal and investment loans). CEF specializes in real estate loans (alongside significant personal loans). On the other hand, private banks primarily specialize in issuing personal loans. However, they still provide other types of credit. For instance, *Bradesco* is a large issuer of agricultural loans, while both *Itau* and

[15]Note that in Brazil there are around 5,500 municipalities, and according to ESTBAN data set only about 3,700 of them had bank access by 2018.

[16]For the details and the outcomes associated with this policy, see Fonseca and Matray (2022).

[17]For example, looking at the period January 2011 - March 2014, around 200 municipalities experienced bank entry. This bank entry into new municipalities was mainly driven by public banks opening their branches. For details on bank entry during this period, see Appendix A.1.1.

| | Public Banks | | Private Banks | |
|---|---|---|---|---|
| Loan category | Amount | % total | Amount | % total |
| Personal Credit | 178,309.8 | 40.88% | 29,638.1 | 78.80% |
| | (523,410.7) | | (403,654.9) | |
| Investment Loans | 63,326.4 | 12.09% | 5,530.1 | 3.98% |
| | (254,192.0) | | (228,385.1) | |
| Agricultural Loans | 216,359.1 | 26.78% | 11,081.5 | 15.03% |
| | (946,357.6) | | (533,934.6) | |
| Mortgages | 139,868.7 | 23.73% | 0.0 | - |
| | (432,065.5) | | (0.0) | |
| Other Credits | 26,757.6 | -2.86% | 569.4 | 2.19% |
| | (1,834,143.0) | | (86,994.2) | |
| N | 99,060 | 80,772 | 85,029 | 48,439 |

Table 1.1: Loan origination and the structure of new loans by bank type over the period Jan 2011 - Mar 2014

Notes: Average amounts of new loans across public and private banks. Structure of new loans calculated based on banks that increased total lending in the period. Public banks were experiencing a decrease in other credits since the amounts of paid loans exceeded amounts of new loans, hence the negative proportion of other credits in the structure of public bank loans. Author's calculations.

*Santander* offer investment loans. It is important to note that private banks do not issue real estate loans in Brazil.[18]

Summary statistics of new loans, calculated over the period from January 2011 to March 2014 and presented in Table 1.1, illustrate some of these differences between public and private banks. We can see that public banks issue all types of credit, while private banks specialize in issuing personal loans (constituting almost 80% of their newly issued loans) with some agricultural and investment loans (and no mortgages). Additionally, public banks issue substantially greater amounts of new loans on a monthly level compared to private banks, on average. While this could indicate that public banks issue larger-sized loans, it likely also reflects the fact that they issue more loans, i.e., have more clients who borrow from them than private banks. Finally, there is high heterogeneity in loan origination across municipalities.

[18]The structure of the asset side of bank balance sheets of these five largest banks and its evolution over the period 2011-2013 is presented in Figure A.3 in the Appendix A.1.2.

### 1.3.1 Government intervention

In March 2012, Brazilian government announced its intention to promote credit supply through the state-owned (public) banks - *Banco do Brasil* and *Caixa Economica Federal*. This increase in credit supply was targeted at both consumers and firms. For example, *Banco do Brasil* credit program "Good for All" ("Bom pra Todos") aimed at increasing credit lines for both micro and small companies and individuals by substantial amounts, while significantly lowering interest rates. Highlights of the program were: R$40 billion for new credit, decrease in average interest rates charged to individuals by up to 45%, and reductions of average interest rates charged to businesses by about 15%. On the other hand, *Caixa Economica Federal* program "Caixa Better Credit" ("Caixa Melhor Crédito") aimed at extending credit lines across various loan categories - personal credit, payroll loans, vehicle financing, as well as credit to micro and small businesses for purchasing machinery, equipment, or even improving company's facilities. As a part of the program, CEF made R$10 billion available to companies. By mid-2012 personal and payroll credit lines grew by about 50% compared to the year before. Moreover, in the period March - September 2012 rates on CEF credit products reached reductions of up to 88%.[19] These credit programs came as a response to the Brazilian government announcement of the R$60 billion package to stimulate production in Brazilian industry and competitiveness of Brazilian companies.

Figure 1.2 presents time series of real GDP growth, inflation and unemployment rate in Brazil over the period 2000-2020. Two vertical lines mark the period around the government intervention. Evidence from the figure suggests that the policy was not a response to an impending crisis.[20] This is very important as the policy was not coinciding with any negative economic shock that could have affected public and private banks in different ways or have negative impact on economic activity. Hence, this setting represents a fruitful ground for studying how and to what extent the economic policy promoting increased credit supply can affect real outcomes in the economy.

[19] Some details about these programs can be found at https://g1.globo.com/economia/noticia/2012/04/bb-reduz-juros-e-amplia-credito-para-empresas-e-pessoa-fisica.html and https://www.idinheiro.com.br/emprestimos/caixa-melhor-credito/.

[20] Joaquim et al. (2023) document that the economic recovery that Brazil experienced after the financial crisis in 2008-2009 was fast.

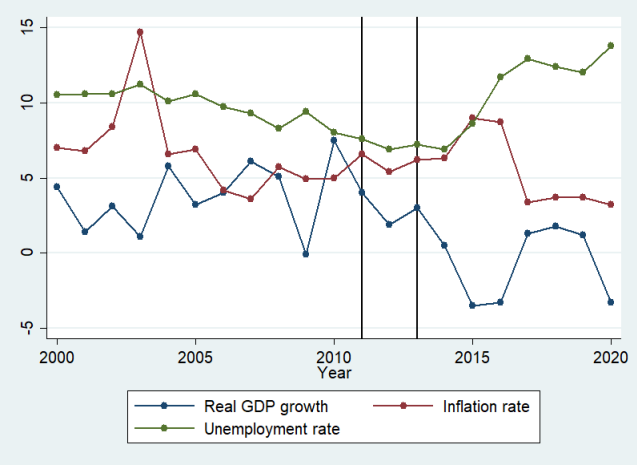



Figure 1.2: Brazil - Macro Series

Notes: The graph presents series of real GDP growth, inflation and unemployment rate over the period 2000-2020. The two vertical lines, denoting 2011 and 2013, mark the period around the time the government policy was introduced.

source: IMF

The biggest concern is whether this policy was truly exogenous from economic activity. A first argument that speaks in favor of exogeneity is that this policy was not introduced as a response to a (forecasted) economic crisis. In the literature it is documented that the quarterly GDP growth in Brazil was above 1.7% throughout the period 2011-2013, and, moreover, GDP forecasts remained stable by June 2012 (Joaquim et al., 2023). Second, same authors show that the credit supply expansion was not driven by political concerns or motives - they find that funds were not disproportionately allocated to municipalities with mayors from the party of the president. This reduces concerns that the allocation of public loans was systematically driven by political capture, and consequently suggests that the intervention was truly exogenous and can be used as a quasi-experiment in assessing the effects of increased credit supply on economic activity. With the aim of keeping the analysis clean of other external shocks in the economy, I will constrain it to the period 2011-2013.

## 1.4 Empirical strategy

My empirical strategy comprises three main steps. In the first step, I aim to demonstrate that the government intervention effectively increased total lending. This involves showing that pub-

lic banks complied with government intentions and increased credit supply, without significantly offsetting private lending. In the next step, I investigate whether competition over customers intensified between public and private banks due to the policy. Finally, in the third step, I assess the extent to which this government intervention affected economic activity, considering the change in bank credit supply as a mediator of this policy.

In the initial step, I analyze trends in loan origination by public banks to establish compliance with the government policy aimed at increasing credit supply in the economy. Subsequently, I examine how changes in public bank lending activity affected credit issuance of private banks. This analysis involves both descriptive methods, providing informal evidence, and regression analysis for a more formal approach. I estimate the following regression:

$$newloans^{priv}_{i,m,t} = \beta_0 + \beta_1 newloans^{pub}_{i,m,t-1} + \mu_t + \mu_{im} + \xi_{i,m,t} \tag{1.1}$$

where $i$ denotes a bank, $m$ denotes a municipality, and $t$ denotes time. The subscript $priv$ refers to a private bank, while $pub$ refers to a public bank. The term $newloans^{priv}_{i,m,t}$ refers to changes in lending of a private bank $i$ in municipality $m$ at time $t$ in one of its loan categories. Meanwhile, $newloans^{pub}_{i,m,t-1}$ represents a set of explanatory variables indicating the (average) monthly amount that public banks issue across their branches in municipality $m$ at time $t-1$, one for each loan category. Time fixed-effects $\mu_t$ and municipality-bank fixed-effects $\mu_{im}$ are included. Finally, $\xi_{i,m,t}$ represents the error term. Inclusion of the municipality-bank fixed effect accounts for specific characteristics of a bank in each municipality. For instance, branches of CEF may specialize solely in issuing new mortgages when other banks have operational branches within the same municipality.

A potential concern for the validity of my results is that, after the policy introduction, public banks might issue loans that would have otherwise been issued by their private competitors. I address this concern by running different regressions given in equation 1.1, establishing relationships between different types of public and private credit and estimating the magnitude of the crowding-out effect.

In the second step, I examine the effects of the policy on competition in the banking sector. specifically focusing on the competition between public and private banks for clients.[21] For this purpose, I use changes in deposit amounts as a proxy for changes in the size of a bank's clientele. Therefore, I empirically assess competition effects by running regressions of the following form:

$$\Delta deposits^{priv}_{i,m,t} = \beta_0 + \beta_1 newloans^{pub}_{i,m,t} + \mu_t + \mu_{im} + \xi_{i,m,t} \tag{1.2}$$

This regression closely resembles the regressions conducted in the first step of the analysis, given by equation 1.1. The key difference lies in the dependent variable, which now represents a change in private bank deposits. Due to the absence of information about the number of clients a bank has, I utilize changes in deposits as a proxy for changes in the customer base. For instance, one can imagine that a client obtaining a mortgage from *Caixa Economica Federal* might also transfer her checking account to CEF. In such a scenario, an increase in new loans issued by public banks, attracting more customers, would likely result in a significant decrease in checking deposits held by private banks. This is also important as it provides insights into whether the competition effects between public and private banks should be accounted for when examining effects of the policy on real outcomes.

In the third step, my goal is to examine the extent to which this policy translates into economic activity and real economic outcomes. As changes in credit supply represent the mediator of this policy, I use total lending as the explanatory variable when estimating real effects of the policy. In order to examine this, I estimate a series of regression specifications of the following form:

$$\log y_{m,t} = \beta_0 + \beta_1 \log TL_{m,t-1} + \beta_2 X_{m,t-1} + \mu_m + \mu_t + \xi_{m,t} \tag{1.3}$$

where $y_{m,t}$ is the outcome of interest (municipality-level GDP, employment, agricultural production, etc.), $TL_{m,t-1}$ is the total lending in municipality $m$ in period $t-1$, $X_{m,t-1}$ represents

[21] One may want to explore other competition aspects in the banking sector, for instance, looking at interest rates offered by different banks. However, due to data limitations, I am not able to discuss competition effects across dimensions other than competition for clients.

variables controlling for changes in credit demand, $\mu_m$ and $\mu_t$ are municipality and time fixed effects, and $\xi_{m,t}$ is the error term.[22]

However, the concern about the endogeneity of total lending, $TL_{m,t}$, remains. This variable contains changes in total lending that result not only from the increase in bank credit supply but also from changes in credit demand. For example, if economic activity in municipality $m$ intensified due to rapid development of the municipality, resulting in an increase in GDP, employment, and wages, which, in turn, would elevate credit demand. This unobserved heterogeneity enters the error term, contributing to the endogeneity issue as it is related to changes in total lending. To some extent, I can address this issue by controlling for observable demand heterogeneity between municipalities, using control variables such as government transfers, wages, and the value agricultural production, which should serve as proxies for changes in credit demand. Nevertheless, the concern persists because of unobserved heterogeneity that I cannot control for.

To mitigate this problem, I will adopt the approach outlined by Imbens and Newey (2009). Specifically, I will attempt to retrieve the effects of the policy on economic outcomes with a 2-stage procedure. In the first stage, I regress total lending using an instrument affecting credit supply while keeping credit demand at a fixed level. Specifically, I interact the fixed pre-policy values of variables controlling for changes in demand (government transfers, wages, and value of agricultural production) with an indicator variable that takes the value 1 for the periods after March 2012. Then, residuals from this first stage regression represent change in total lending that is attributable to credit demand. I use these residuals as an additional control variable in the second stage regression where I regress outcomes of interest on total lending. The identifying assumption is that, conditional on these residuals, total lending becomes independent of the error term, resolving the endogeneity issue.

Econometrically, the main regression that I want to estimate is:

[22] I also deal with the issue that dependent variables in equation 1.3 are available at an annual frequency, while total lending is available at a monthly frequency. To deal with this, I define the average total lending in municipality $m$ over a year $t-1$ to be the explanatory variable.

$$\log y_{m,t} = \gamma X_m \times \log TL_{m,t-1} + \mu_m + \mu_t + u_{m,t}$$

where $X_m$'s represent the pre-policy values of variables controlling for observable demand heterogeneity between municipalities, and these controls are interacted with total lending. Because of the previously described endogeneity problem with total lending, I will use an instrument in the first stage of the procedure to extract the portion of total lending that is attributable to changes in credit demand. To do this, I will use the following first stage regression:

$$\log TL_{m,t} = \gamma X_m \times Post_t + \mu_m + \mu_t + \varepsilon_{m,t}$$

My instrument consists of interactions between variables controlling for observable demand heterogeneity between municipalities with the indicator variable $Post_t$ that takes the value 1 for all periods after March 2012. Assuming that the exclusion restriction is satisfied, and estimating the last equation, I can obtain the residuals $\hat{\varepsilon}_{m,t}$ that should represent the change in total lending that is not attributable to government intervention (constructed control variable). The critical step in doing this is assuming the orthogonality between total lending $TL_{m,t}$ and the error term from the main regression $u_{m,t}$ conditional on $\hat{\varepsilon}_{m,t}$, $TL_{m,t} \perp u_{m,t}|\hat{\varepsilon}_{m,t}$.

If this assumption is satisfied, I can then go to the second stage and estimate the effect the government intervention had on economic outcomes using the following regression:

$$\log y_{m,t} = \gamma(X_m) \times \log TL_{m,t-1} + \delta_1(X_m) \times \hat{\varepsilon}_{m,t} + \left[\delta_2(X_{1m}) \times \hat{\varepsilon}^2_{m,t} + \right]\mu_m + \mu_t + u_{m,t}$$

Introducing the constructed control variable $\hat{\varepsilon}_{m,t}$ into the regression (and also its non-linear form), if the assumption holds, means that this term takes care of changes in total lending that is due to the changes in credit demand, so I can estimate the desired effect.

In fact, the approach I take here is a slightly modified version of the Imbens and Newey (2009) procedure. In their paper, they consider models that are non-separable in disturbances. They show

that the cumulative conditional distribution function of the endogenous regressor given the instrumental variable, estimated from the first-stage regression, can be used as a constructed control variable in the main regression to identify causal effects of the endogenous regressor on the response variable. Equivalently, as they show, one can use the CDF of the residuals obtained in the first-stage regression as a constructed control variable in the main regression. Unlike them, I use the residuals from the first-stage regression directly as a constructed control variable in the second-stage regression when I estimate the effect of changes in total lending on real outcomes. In this case, this is equivalent to their approach, as I use linear specifications with additive disturbances.

## 1.5 Bank Lending Activity and Competition in the Banking Sector

The government intervention introduced in March 2012 aimed to increase credit supply to households and firms. In this section, I assess the success of this policy in increasing bank lending, examining two stages: (i) compliance of public banks with the policy (direct effect), and (ii) resulting changes in loan origination by private banks, especially the extent of potential crowding out of loans (indirect effect). Moreover, I study how the policy affected competition for clients between public and private banks.

### 1.5.1 Trends in Loan Origination

I begin by evaluating the effects of government intervention on total credit supply, examining the evolution of new loans across loan categories for both public and private banks (Figure 1.3). The first observation is that public banks, on average, significantly increased credit supply across all loan categories after March 2012. New personal loans almost doubled, new investment loans more than tripled, and average amounts of new agricultural loans and mortgages increased by about 75% and 60%, respectively.[23] Moreover, private banks' activity appears to be relatively similar before and after government intervention, suggesting that, even if there was some crowding out of loans, it was only partial. This is evident for investment loans (issued at about the same rate before

[23] Table A.1 in Appendix A.1.3 confirms these numbers.

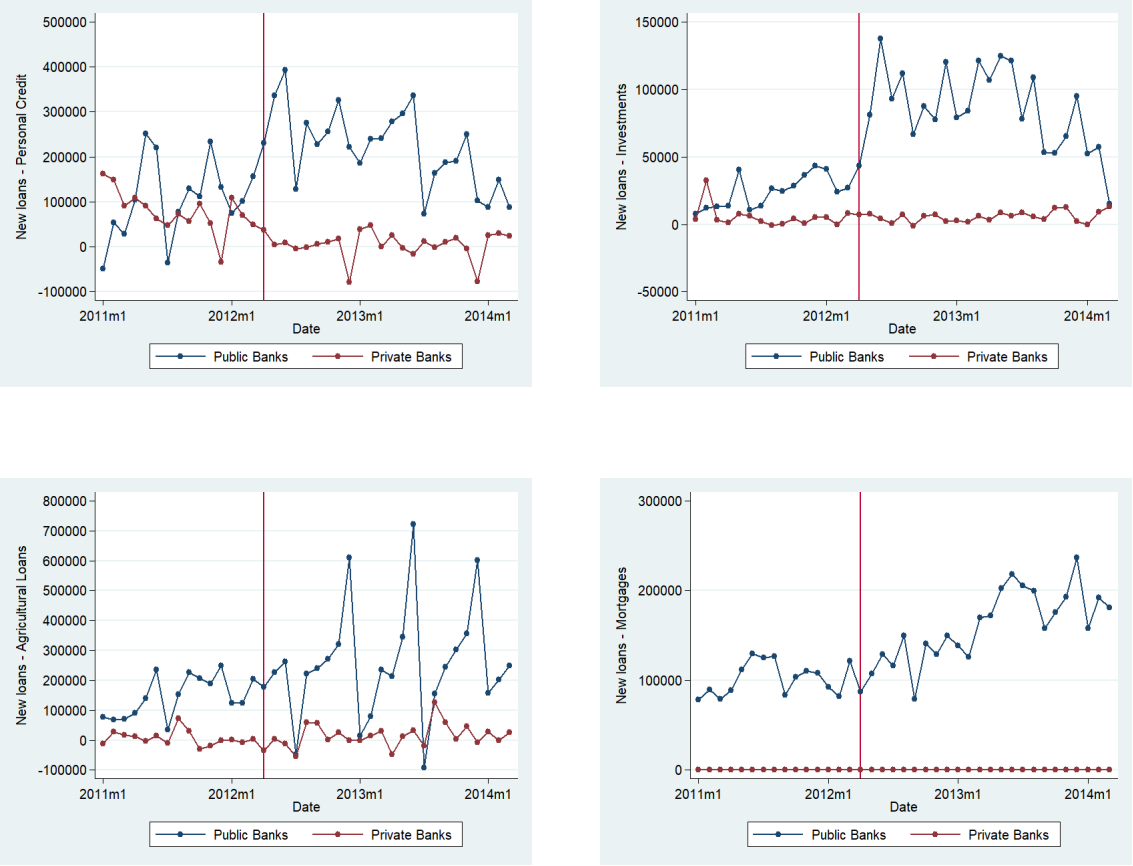



Figure 1.3: Trends in loan categories across public and private banks

and after) and mortgages (not issued at all by private banks). In the case of agricultural loans, there is even a slight increase in private banks' agricultural loans after March 2012, amplifying the overall increase in agricultural lending by public banks. Finally, while there is a small concern about potential crowding out in the case of personal credit as private banks lowered the amounts of new personal loans after March 2012, public banks significantly increased it by an average of R$110,000. This suggests only a partial crowding out of private banks' personal loans by public banks. However, Figure 1.3 presents averages of new loans across a heterogeneous set of municipalities, and does not provide evidence for the presence and size of crowding out. I address this in the regression analysis below.

To understand the driving forces behind the increase in lending after March 2012, I analyze new loan origination for each individual bank across loan categories, as depicted in Figure 1.4.[24]

[24]It is important to note here that CEF was the only bank actively opening new branches after the policy was

For personal loans (Panel A), the surge is primarily attributed to new personal loans issued by *Caixa Economica Federal* (CEF). CEF significantly increased the issuance of new personal loans across municipalities with existing branches (middle panel), and in areas where new branches were established after the policy. In contrast, other banks generally experienced about the same level of demand for personal loans both pre- and post-policy. *Banco Santander* was an exception, showing a decreasing trend in personal loan demand over the period. This observation is crucial in mitigating concerns about potential crowding out, as the overall amount of new personal loans is on the rise.

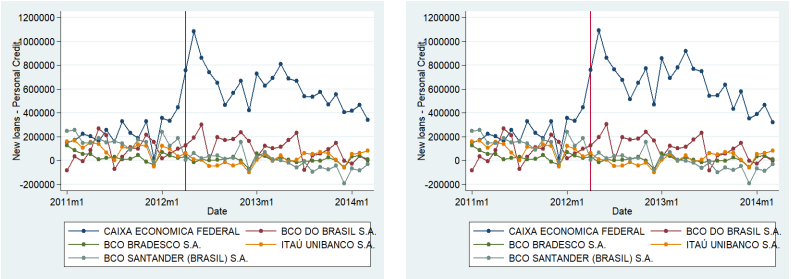
In the case of investment loans (Panel B), the increase in the amount of investment loans was driven by newly issued investment loans of public banks. Namely, both BB and CEF increased investment lending after March 2012. Private banks, on the other hand, maintained a relatively constant level of newly issued investment loans before and after the policy, indicating no substantial crowding out of investment loans. *Banco Santander* even demonstrated a significant increase in new investment loans post-policy.

The pattern for agricultural loans (Panel C) mirrors the distinction between public and private banks, with *Banco do Brasil* driving new agricultural loans for public banks, and *Banco Bradesco* and *Banco Santander* playing significant roles for private banks. However, there is notable variability in new agricultural loans, likely linked to seasonality. Spikes occur towards the end of each year, corresponding to high costs that farmers incur for planting and growing their crops. Additionally, mid-year spikes coincide with farmers' final field preparations for winter and potential investments in machinery. Nevertheless, there was a significant increase in amounts of agricultural loans when I consider changes relative to the same period of the previous year to account for this seasonality. This is particularly visible in the case of BB loan origination around mid and end of the year.

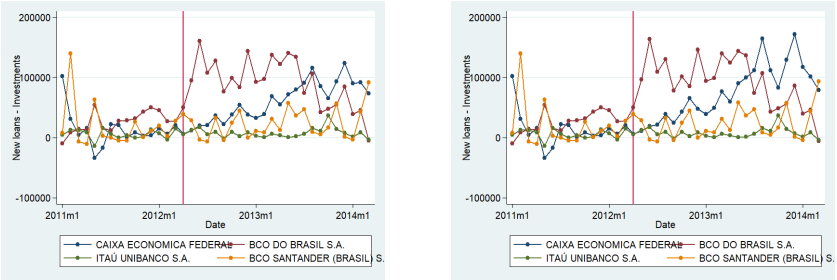
In Panel D, mortgages are shown for *Caixa Economica Federal* as it is the only bank issuing

introduced in March 2012. To account for this, I present trends in new loan origination of those branches separately for personal credit and mortgages, the two types of loans that new branches of CEF focused on issuing.

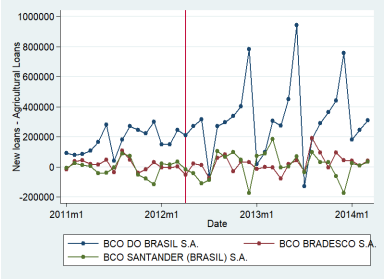
Panel A. Trends in new personal credit. (Notes: Left panel includes all branches of each bank. Middle panel includes all branches of individual banks that were operating prior to March 2012.)




Panel B. Trends in new investment loans. (Notes: Left panel includes all branches of each bank, while the right panel includes only branches that operated before the policy was introduced. *Banco Bradesco* excluded since investment loans represent a negligible part of its balance sheet.)




Panel C. Trends in new agricultural loans.(Notes: *Caixa Economica Federal* and *Itau* are excluded since agricultural loans represent a negligible part of their balance sheets.)




Panel D. Trends in new mortgages - *Caixa Economica Federal*. (Notes: *Caixa Economica Federal* is the only bank issuing mortgages. Top panel shows trends across all branches of CEF. Middle panel shows trends for branches present throughout the period, while the right panel shows this for newly opened branches of CEF.)

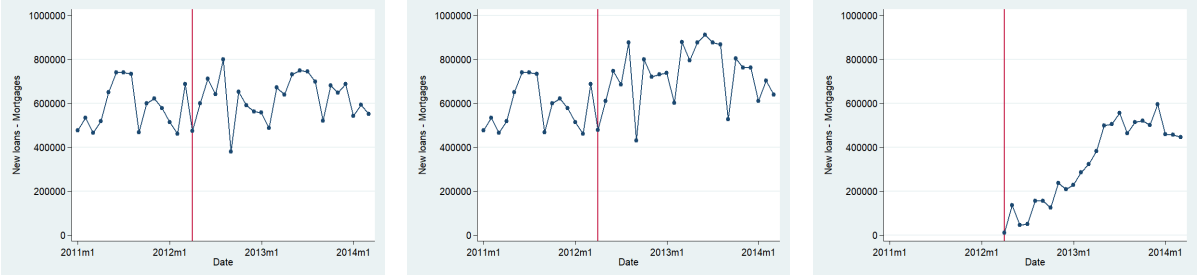



Figure 1.4: Trends in new loans by bank

| | Public Banks | | Private Banks | |
|---|---|---|---|---|
| Loan category | Pre-policy | Post-policy | Pre-policy | Post-policy |
| Personal Credit | 39.93% | 41.34% | 91.83% | 70.42% |
| Investment Loans | 5.38% | 15.34% | 1.79% | 5.39% |
| Agricultural Loans | 28.53% | 25.93% | 5.45% | 21.19% |
| Mortgages | 27.25% | 24.51% | - | - |
| Other Credits | -1.08% | -7.11% | 0.92% | 3.00% |
| N | 26,380 | 54,392 | 18,966 | 29,473 |

Table 1.2: The structure of new loans pre- and post-policy

new mortgages.[25] While it may seem there was no increase in mortgages from the left panel, a distinction between CEF's branches operational before March 2012 and the newly opened branches reveals an increase in mortgage issuance relative to the pre-policy period.

Table 1.2 presents the structure of new loans created by both public and private banks. A striking observation is the tripling of the share of investment loans in the structure of newly originated loans. This trend is consistent across both public and private banks. Given the nature of these loans, it is essential to assess whether this increase led to positive outcomes for municipalities, as measured by GDP and employment, providing evidence on the efficiency of these loans. Additionally, the proportion of other types of loans in total loan origination has not changed much across public banks, suggesting that these banks did not shift focus from some types of loans to others. In contrast, private banks exhibit a substantial increase in origination of agricultural loans, mainly at the expense of personal loans, which were the primary focus of private banks before the policy intervention.[26]

To examine the intensity of the increase in lending, I contrast the amount of newly issued loans to municipality-level GDP, as illustrated in Figure 1.5. I split municipalities based on their

[25]BB is also issuing some mortgages, but this is not at any meaningful level for the analysis, especially relative to mortgages issued by CEF. Hence, only the evolution of mortgages issued by CEF is presented in the figure.

[26]The effect here is twofold: namely, I indeed observed a decrease in new personal loans issued by private banks when looking at trends. However, this drop in the share of personal loans in their loan structure is not solely due to this decrease, but also due to the observed increase in investment and agricultural loans.

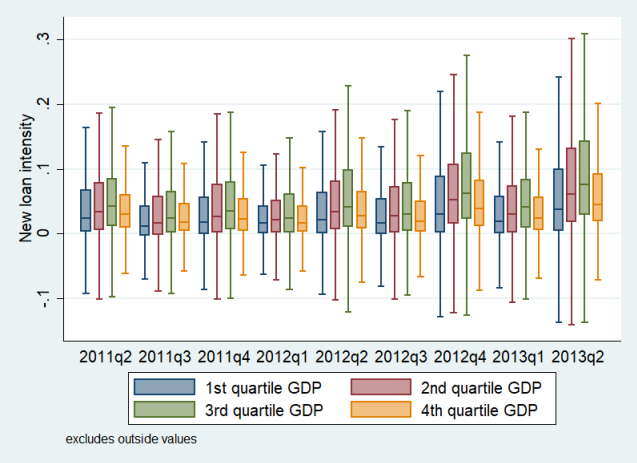



Figure 1.5: New loans relative to GDP

Notes: Newly issued loans are contrasted to the municipality level GDP from 2011. Municipalities are broken down into 4 groups according to their wealth, as measured by GDP.

GDP level. I chose to contrast amounts of new loans to a fixed GDP level from 2011.[27] Notably, new loans average 4.28% of the GDP level over the period in question.[28] This ratio remains relatively stable across the sample period, with an observable increase in loan intensity after the policy intervention. This confirms that banks issued larger amounts of new loans following the government intervention. Interestingly, the richest municipalities, constituting the fourth percentile of the sample by GDP level from 2011, exhibit a lower level of new loan intensity, comparable to the poorest municipalities. Moreover, Figure 1.5 reveals a certain level of seasonality in new loan origination, with higher loan amounts observed in the second and fourth quarters. This seasonality suggests variations in borrowing patterns throughout the year.

The presented evidence indicates an increase in credit supply of public banks following the government intervention in March 2012. Moreover, there seems to be only a mild, if any, crowding out effect on private banks' loans. As a result, there was an overall increase in total credit supply. However, two concerns need to be addressed before I can draw a conclusion.

First, it is conceivable that even in the absence of intervention, credit supply could have in-

[27] I divide the GDP level with 12 in order to obtain "monthly GDP", so that I can contrast average monthly amounts of new loans to a monthly measure of GDP.

[28] At the world level, new loans (net lending to private sector) accounted for 0.78%, according to the World Bank data (see https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS?end=2022&start=1960&view=chart). I calculated this number as the change in domestic credit to private sector from 2011 to 2012.

creased, as private banks might have issued more loans had public banks not attracted their existing and potential customers. For instance, customers might have sought agricultural loans from Banco Bradesco if there had been no intervention, leading to improved conditions for obtaining a loan from Banco do Brasil. To address this concern, I will explore complementarities between various loan categories of public and private banks next.

Second, even without the policy, the demand for credit might have increased, possibly due to increased economic activity and higher wages. Consequently, the observed increase in loan amounts may not be entirely attributed to an increase in supply resulting from government intervention but could be influenced by increased credit demand. To tackle this issue, I will control for changes in demand when assessing the effects of increased lending on real economic outcomes in the next section.[29]

### 1.5.2 Assessing the Size of Crowding-out

I proceed to identify potential complementarities between different loan categories of public and private banks that are observed in loan origination patterns discussed above. This approach allows me to assess both the significance and the extent of crowding out of private bank credit by their public counterparts. In what follows, I will use the panel structure of the data to estimate the following regression:

$$newloans^{priv}_{i,m,t} = \beta_0 + \beta_1 newloans^{pub}_{i,m,t-1} + \mu_t + \mu_{im} + \xi_{i,m,t} \tag{1.4}$$

In the first set of regressions, I examine the relationship between new loans of private banks for different loan categories and new loans across branches of their public competitors within the municipality. For instance, in a municipality with one branch of *Banco Bradesco*, two branches of *Banco do Brasil*, and one branch of *Caixa Economica Federal*, the explanatory variables include average new loans across the three branches of BB and CEF, with one variable for each loan

[29] An important consideration is that, although the policy was not introduced concurrently with economic crisis, the government intervened as it was worried about the potential economic slowdown, which speaks against the story that the increase in total credit supply was (solely) demand driven.

| | Private: Personal (1) | Private: Investment (2) | Private Agricultural (3) |
|---|---|---|---|
| Public: Personal Credit | 0.0133* | -0.0029 | -0.0128 |
| | (0.0079) | (0.0038) | (0.0138) |
| Public: Investment Loans | -0.0026 | 0.017 | -0.0269* |
| | (0.0068) | (0.0088) | (0.0161) |
| Public: Agricultural Loans | -0.0001 | 0.0010 | -0.0169* |
| | (0.0021) | (0.0017) | (0.0089) |
| Public: Mortgages | -0.0099 | 0.0029 | 0.0339 |
| | (0.0107) | (0.0073) | (0.0255) |
| Public: Other Credits | -0.0018 | 0.0006 | -0.0125** |
| | (0.0013) | (0.0009) | (0.0057) |
| Time FE | Y | Y | Y |
| Municipality × Bank FE | Y | Y | Y |
| N | 64,166 | 25,670 | 30,678 |

Table 1.3: Regression of newly issued loans by private banks on newly issued loans of public banks

category. The results of these regressions are presented in Table 1.3.

Most of the coefficients in the regressions are non-significant, aligning with patterns I observed when I examined trends in loan origination. However, there are a couple of points worth making. First, there is a positive and significant relationship between the issuance of personal loans by public and private banks, as evident in specification (1). This may seem counterintuitive when compared to conclusions drawn from trends in new personal loan issuance. However, when looking at trends in personal credit origination, I looked at averages across highly heterogeneous municipalities. It is possible that in municipalities where public banks increased personal loans, private banks did so by a smaller margin, and in municipalities where public banks decreased personal loans, their private competitors made substantial reductions. Consequently, the overall average may still show a decrease in newly issued personal loans by private banks, while the relationship to personal credit supply from public banks remains positive. Second, worth noting is a significant negative relationship between newly issued agricultural loans of public and private banks, as ev-

| | Bradesco: Personal (1) | Bradesco Agricultural (2) |
|---|---|---|
| BB: Personal Credit | 0.0134 | 0.0213 |
| | (0.0100) | (0.0183) |
| BB: Investment Loans | 0.0009 | -0.0194 |
| | (0.0049) | (0.0159) |
| BB: Agricultural Loans | -0.0015 | -0.0043 |
| | (0.0033) | (0.0102) |
| Time FE | Y | Y |
| Municipality × Bank FE | Y | Y |
| N | 14,955 | 6,464 |

Table 1.4: Relationship between loans issued by *Banco do Brasil* and *Banco Bradesco*

ident in specification (3). This suggests a low but significant crowding-out effect for agricultural loans. To put it differently, if a public bank issues new agricultural loans in one period, it leads to a subsequent decrease in agricultural loans issued by its private competitor(s) in the following period.

However, the high heterogeneity across municipalities in the sample calls for a more detailed analysis of the data. In what follows, I will estimate a set of regressions similar to regression equation 1.4, aiming to establish relationships between specific loan categories in certain municipalities, considering the characteristics of various banks' balance sheets.

First, I focus on examining the relationship between *Banco do Brasil* and *Banco Bradesco* in municipalities where only those two banks operate. Moreover, I will restrict the analysis to certain loan categories based on these banks' balance sheets - *Banco do Brasil* issues personal, investment and agricultural loans, while *Banco Bradesco* specializes in personal and agricultural loans. The results of these regressions are presented in Table 1.4.

Reviewing Table 1.4, I do not observe a significant effect. However, regarding the sign on agricultural loans in column (2), I can say that it suggests a partial but non-significant crowding-out effect.

| | Private: Personal (1) | Private Investment (2) |
|---|---|---|
| CEF: Personal Credit | -0.0047 | 0.0003 |
| | (0.0037) | (0.0004) |
| CEF: Mortgages | 0.0109 | -0.0030 |
| | (0.0106) | (0.0050) |
| Time FE | Y | Y |
| Municipality × Bank FE | N | N |
| N | 866 | 418 |

Table 1.5: Relationship between loans issued by *Caixa Economica Federal* and private banks

Second, I aim to explore the effects of *Caixa Economica Federal*, the only bank issuing mortgages, on its private competitors. To achieve this, I restrict the regression analysis to the subset of municipalities where CEF is the sole public bank, and there is at least one branch of at least one private bank in that municipality. The results of these regressions are presented in Table 1.5.

Examining the results, there is no significant relationship between *Caixa*'s issuance of mortgages and private banks' issuance of new loans. However, the positive sign in specification (1) on new mortgages suggests that newly issued mortgages by CEF are followed by an increase in new personal loans issued by its private competitors. On the other hand, the increase in mortgage issuance is related to decreased amounts of investment loans issued by private banks. Still, neither of the effects is significant, suggesting no crowding-out.

Combined with the evidence from trends in new loans, the regression analysis supports previous conclusions that government policy had an effect in increasing total credit supply. It seems safe to conclude that the increased credit supply by public banks was not offset by the decreased credit supply of their private competitors. Moreover, as observed in the case of CEF, it might have even slightly increased the demand for credit from private banks. These established relationships also address the problem that public banks were issuing loans that might have otherwise been issued by private banks in the absence of the policy.

### 1.5.3 Client Retention

If public banks are lowering interest rates and attracting more clients, one consequence could be that these new clients switched from private to public banks as they obtained loans with them. If this was indeed the case, it implies that the policy intensified competition between public and private banks for customers. To investigate this, I will conduct regressions of changes in checking and savings deposits of private banks on new loan issuance by public banks.[30] The regression equations are as follows:

$$\Delta deposits^{priv}_{i,m,t} = \beta_0 + \beta_1 newloans^{pub}_{i,m,t} + \mu_t + \mu_{im} + \xi_{i,m,t} \tag{1.5}$$

where the dependent variable is the change in deposits, which proxies for the client retention. Note that I am not using lagged loan variables. The results are presented in Table 1.6. While the estimated relationships between new loans of public banks and deposits of private banks are mostly negative, there is no significant decrease in deposits created by private banks following the changes in credit supply of public banks. This is especially true for checking deposits. If we think of checking deposits as a proxy for where people receive their wages, the evidence here suggests that people are not moving their checking accounts away from private banks after March 2012. For instance, I would have expected a significant number of people taking up new mortgages to move their checking accounts from private banks to CEF. However, this is not confirmed in Table 1.6. Therefore, these results suggest that the competition for customers did not intensify following the government intervention.

## 1.6 Effects on Economic Activity

In this section, I turn to studying the effects of the increase in total lending on real outcomes. I focus on the effects of increased lending activity on GDP and (formal) employment at the municipality level.

[30] For trends in deposit creation over the period 2011-2013, see Appendix A.1.4.

| | Private: Checking (1) | Private: Savings (2) |
|---|---|---|
| Public: Personal Credit | -0.0058 | -0.0196*** |
| | (0.0075) | (0.0072) |
| Public: Investment Loans | 0.0054 | 0.0044 |
| | (0.0099) | (0.0056) |
| Public: Agricultural Loans | -0.0041 | -0.0039*** |
| | (0.0046) | (0.0019) |
| Public: Mortgages | -0.0080 | 0.0096 |
| | (0.0122) | (0.0080) |
| Public: Other Credits | 0.0001 | 0.0016 |
| | (0.0024) | (0.0017) |
| Time FE | Y | Y |
| Municipality × Bank FE | Y | Y |
| N | 66,056 | 66,056 |

Table 1.6: Relationship between change in deposits of private banks and loan origination of public banks

### 1.6.1 Real Outcomes at the Municipality Level

The Brazilian government introduced the policy with the intention of extending credit to households and firms across the economy due to concerns about an economic slowdown. As demonstrated in the previous section, the policy successfully increased credit. However, the question remains whether this increased lending activity had positive effects on real outcomes. To address this question, I run regressions of the form:

$$\log y_{m,t} = \beta \log TL_{m,t} + \gamma X_{m,t-1} + \mu_m + \mu_t + u_{m,t} \tag{1.6}$$

where $y_{m,t}$ is the outcome variable (GDP or employment) in municipality $m$ at time $t$. $TL_{m,t-1}$ is the total lending in municipality $m$ at time $t-1$. More precisely, it is defined as the average of total lending in municipality $m$ over the year $t-1$. I use the lag of total lending to allow for some

time for the effects of lending to realize.

As there is a concern that that the increase in total lending might be driven by higher credit demand rather than increased credit supply, I introduce control variables to proxy for the greater demand for lending. $X_{m,t-1}$ represents these control variables, which include the average municipality payroll, government transfers to municipalities, and the annual value of agricultural production at the municipality level. These variables serve as a proxy for the market size. In other words, as wages increase or the government invests more money into a municipality, this can impact households and firms demand, including credit demand. Given that many municipalities in my sample are smaller, with a significant portion of their income coming from agricultural activity, I also include the annual value of agricultural production as a proxy for demand. Additionally, I include a series of fixed effects (region, state, meso-region, municipality, urbanity) controlling for specific, fixed characteristics of a geographic area, like the size of the municipality or the quality of land in a particular state or meso-region. Furthermore, I include time fixed effects to account for time-specific events.

I conduct the regressions on a sample comprising all municipalities where only the five largest banks operate, totaling around 2400 municipalities. Initially, I run the regression on the entire sample, irrespective of whether a municipality had access to a bank before January 2011 or experienced bank entry from one of those five banks only after January 2011, having had no bank access before this date. The results are presented in specifications (1) and (2) in Table 1.7. However, there is a concern about potential correlation between bank entry and economic activity at the municipality level. If a municipality starts developing, it will become richer, concurrently elevating the demand for banking products such as bank credit. Recognizing this as an opportunity, banks may decide to enter this emerging market, expanding their services, growing their business, and increasing their customer base. Hence, a bank's entry decision becomes endogenous in a sense that it essentially enters its profit-maximization problem, weighing the potential benefits of acquiring new customers and the drawbacks of potentially higher default rates in new markets.[31] To address this, I repeat the

[31] As argued in section 3, public banks in Brazil are sometimes directed by the government to provide banking services to market segments that may not be inherently highly profitable. This makes the entry decision of public banks

| | GDP | | | | Employment | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| log(TL) | 0.0047 | 0.0033 | 0.0036 | 0.0027 | 0.0354** | 0.0357** | -0.0010 | 0.0009 |
| | (0.0038) | (0.0041) | (0.0113) | (0.0115) | (0.0167) | (0.0166) | (0.0177) | (0.0180) |
| log(TT) | - | Y | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Municipality FE | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 6,682 | 6,553 | 6,524 | 6,403 | 6,667 | 6,554 | 6,509 | 6,404 |

Table 1.7: Effect of increase in total lending on GDP and employment
Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

analysis while excluding the approximately 200 municipalities that experienced bank entry within the time horizon of my analysis. The results of these regressions are presented in specifications (3) and (4) in Table 1.7.

The results indicate a negligible impact of increased lending on both GDP and employment across various model specifications. Specifically, the estimated effect is minimal, suggesting that a 1% increase in total lending corresponds to an average GDP increase of only 0.004%. Similarly, the impact on employment is modest, with an average increase of 0.035%. These findings imply that the observed increase in total lending has virtually no discernible effect on economic activity. When excluding municipalities that experienced bank entry during the period 2011-2013, the estimated effects for both GDP and employment become essentially zero.[32,33]

To better understand these puzzling results and unravel the effects of the increased lending, I conduct a series of robustness checks aimed at exploring this question and offering possible

somewhat exogenous. This presents a potential avenue for future research, offering insights into the performance of public banks based on whether the entry into a new market was a strategic choice or a directive from the government.

[32]It could be that the response of real outcomes was different depending on how financially constrained a municipality is. I use municipality income as a proxy for the magnitude of municipality's financial constraints; still I do not observe economically significant effects of the policy on real outcomes. Results are presented in Appendix A.2.1.

[33]I also check the effects on informal employment. For details, see Appendix A.2.5.

explanations. One hypothesis worth investigating is whether the increase in lending had spillover effects across neighboring municipalities rather than having an effect at the very local level. This scenario could occur if, for instance, consumers used personal loans to augment their spending, not just within their local area but also in surrounding municipalities, that is, at the regional level, contributing to regional economic activity. To investigate this possibility, I will utilize IBGE's administrative divisions categorizing municipalities into larger regions such as micro- and meso-regions, which share economic activity.

Before delving into these robustness checks, I will address the potential endogeneity issue associated with total lending.

### 1.6.2 Addressing the Endogeneity of Total Lending

Despite incorporating control variables in the previous regressions, there remains a concern about the endogeneity of total lending. As discussed earlier, from the data I only observe the credit market equilibrium in each municipality, making the variable *total lending* reflective of both credit supply and demand. To address this concern, I employ the procedure outlined by Imbens and Newey (2009) to disentangle the portion of increased lending attributable to changes in credit supply. The goal is to estimate the following regression:

$$\log y_{m,t} = \gamma(X_{1m}) \times \log TL_{m,t-1} + \delta_1(X_{1m}) \times \hat{\varepsilon}_{m,t} + \delta_2(X_{1m}) \times \hat{\varepsilon}^2_{m,t} + \beta X_{2,m,t-1} + \mu_m + \mu_t + u_{m,t}$$

where $\hat{\varepsilon}_{m,t}$ serves to control for the endogenous portion of $TL_{m,t-1}$, representing the share of the increase in total lending associated with changes in credit demand. This term, $\hat{\varepsilon}_{m,t}$, represents the residuals coming from the first-stage regression formulated as follows:

$$\log TL_{m,t-1} = \gamma(X_{1m}) \times Post_t + \beta X_{2,m,t-1} + \mu_m + \mu_t + \varepsilon_{m,t}$$

This approach relies on the assumption that $\log TL_{m,t-1}$ becomes independent of $u_{m,t}$ once I condition on $\hat{\varepsilon}_{m,t}$ (alongside other control variables).

In the first-stage regression, $Post_t$ interacted with $X_{1m}$ serves as an instrument for shifts in credit supply, and thus, the residual $\hat{\varepsilon}_{m,t}$ is supposed to capture changes in total credit attributable to the changes in credit demand.[34] $X_{1m}$ includes pre-policy log-levels of income measures - the average municipality wage (recorded at the end of 2011), total government transfers to the municipality (available at a monthly frequency), and the total value of agricultural production within the municipality in 2011 (available at a yearly frequency). Defined in this way, the instrument is designed to capture changes in credit supply, because it holds the demand fixed at pre-policy levels. The inclusion of variables from 2011 in the instrument also provides a level of exogeneity to economic activity in 2012 and 2013. In what follows, I explore whether the instrument satisfies necessary conditions, with a particular focus on the relevance condition, which is easier to test for.

On the other hand, $X_{2,m,t-1}$ comprises additional control variables, such as lagged wage, lagged total value of agricultural yearly production, lagged government transfers to municipality aggregated to the yearly level, and more structural control variables. These structural control variables include fixed effects for region, state, meso-region, municipality, urban/rural/intermediate categorization of the municipality, and whether the municipality is in the Amazon area. Additionally, I include the time fixed effects. The purpose of these controls and fixed effects is to account for heterogeneity between the municipalities.

I employ the same set of controls in the main regression, where I interact terms from $X_{1m}$ with $\hat{\varepsilon}_{m,t}$ aiming to control for the portion of changes in total lending attributable to shifts in credit demand.

I estimate several specifications of the regression, In specifications (1) and (2), I use the entire sample, which includes both municipalities that had bank access prior to January 2011 and those that experienced a bank entry only after this date. In specifications (3) and (4), the sample is constrained to a balanced panel containing only those municipalities that had at least one operational bank branch prior to January 2011. Additionally, I distinguish between specifications that include

[34] In additional analysis, I use various measures of public bank presence within a municipality as instruments for shifts in credit supply. As policy mediators, a greater presence of public banks within a municipality should lead to larger shifts in credit supply. However, the estimated effects of the policy remain negligible, and measures of public bank presence turned out to be weaker instruments. These results are presented in Appendix A.3.

| | GDP | | | | Employment | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Marginal effect | 0.0018 | 0.0021 | -0.0019 | -0.0022 | 0.0035** | 0.0037** | 0.0033 | 0.0025 |
| (p-value) | (0.281) | (0.230) | (0.626) | (0.591) | (0.033) | (0.027) | (0.158) | (0.169) |
| log(TT) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(wage) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(agrpr) | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}_{m,t}$ | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}^2_{m,t}$ | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Municipality FE | Y | Y | Y | Y | Y | Y | Y | Y |
| F-stat | 0.92 | 1.38 | 0.34 | 0.66 | 7.48 | 4.34 | 1.97 | 1.47 |
| (p-value) | (0.429) | (0.218) | (0.799) | (0.685) | (0.0001) | (0.0002) | (0.116) | (0.184) |
| N | 6,553 | 6,553 | 6,403 | 6,403 | 6,554 | 6,554 | 6,404 | 6,404 |
| *1st stage* | | | | | | | | |
| F-stat | 6.99 | 6.99 | 8.46 | 8.46 | 6.99 | 6.99 | 8.46 | 8.46 |
| (p-value) | (0.072) | (0.072) | (0.037) | (0.0037) | (0.072) | (0.072) | (0.037) | (0.037) |

Table 1.8: Effect of increase in total lending on GDP and employment (Imbens and Newey)
Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

only the linear term $\hat{\varepsilon}_{m,t}$, controlling for changes in total lending attributable to changes in credit demand (specifications (1) and (3)), and the specifications that include the quadratic form of this term (specifications (2) and (4)).

There are several things to note from results presented in Table 1.8. Firstly, irrespective of the sample used for the analysis, the instrument is relevant, although not very strong. This is illustrated in the bottom panel of Table 1.8, presenting the results of the F-test conducted following the first step regression.[35,36]

[35]Indeed, the F-statistic for instrument relevance does not exceed 10, which is considered a "rule-of-thumb" value for testing the full rank condition of instruments in IV regressions. However, it is worth noting that the p-values associated with these F-statistics are below the 10% level and 5% level for the full sample and after excluding municipalities that had no bank presence before January 2011, respectively.

[36]I also conduct regressions where I regress the residuals from the main regression, $\hat{u}_{m,t}$, on the instrument. Although this is not an actual test of the exclusion restriction, the lack of a significant relationship, as indicated by both

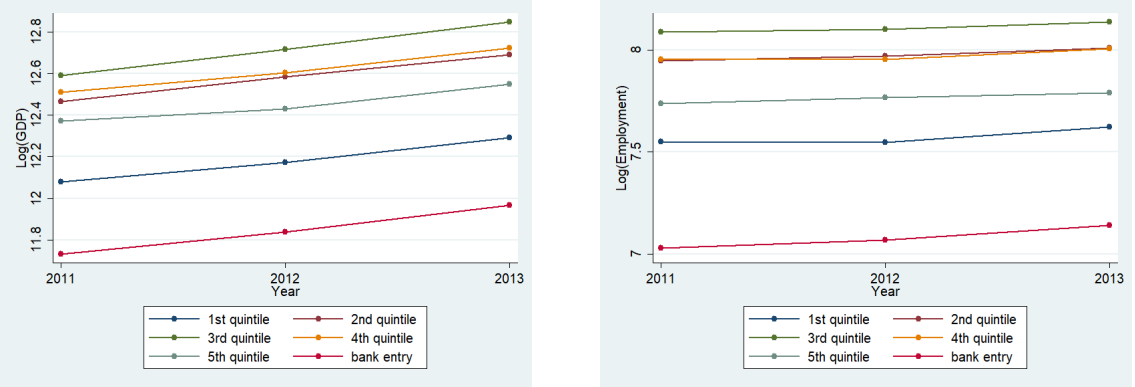



Figure 1.6: Evolution of GDP and employment across municipalities experiencing different level of increase in total lending

Secondly, the results indicate that the effect of the increase in total lending on economic activity is virtually zero, confirming the results obtained before. Specifically, a 1% increase in total lending leads to a 0.002% increase in GDP and a 0.003% increase in employment, on average. The only significant effect is the impact of total lending on employment when considering the entire sample. However, once the 200 municipalities that experienced bank entry only after January 2011 are removed, this effect becomes insignificant.

Finally, it is important to note that the coefficients on $\hat{\varepsilon}_{m,t}$ (and $\hat{\varepsilon}^2_{m,t}$ in specifications where the quadratic term is included) are jointly zero.[37] This implies that there is no selection on unobservables, especially in the case of GDP. In other words, it means that for two municipalities that experienced different levels of increase in total lending, the change in GDP/employment was the same. This can be confirmed by looking at the evolution of GDP/employment across municipalities that experienced different levels of increase in total lending.

To show this, I initially categorize municipalities into five different bins (quintiles) based on the size of the change in total lending they experienced after the government intervention. The first bin comprises municipalities with the smallest change in total lending, while the fifth bin includes those with the highest increase in total lending. Additionally, I create a separate bin for

jointly and individually non-significant coefficients on the instrument, suggests that the exclusion restriction should indeed hold.

[37] p-value for the F-statistics is very high in GDP regressions, while it is above the 10% level for the employment regressions where I constrain the subset.

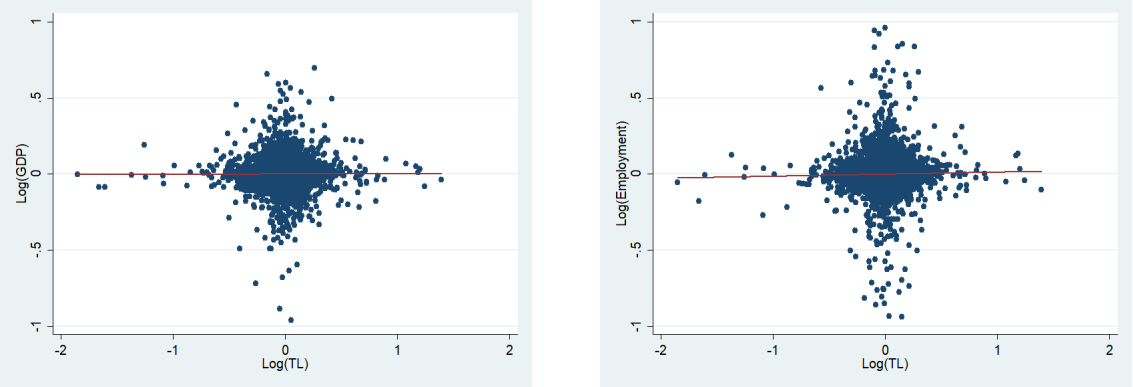



Figure 1.7: Changes in GDP and employment plotted against changes in total lending

all municipalities that had no bank presence before January 2011 but experienced bank entry after this date. The evolution of GDP/employment is then depicted in Figure 1.6.

These graphs validate the regression findings that the effect of the increase in total lending on economic activity was practically negligible. Specifically, in the case of GDP, the left panel of Figure 1.6 illustrates that the change in GDP was the same regardless of variations in changes in total lending across municipalities (with a minor exception observed in the group that experienced the greatest increase in total lending). In the case of employment, there was almost no change in employment for the four quintiles with the most significant increase in total lending. However, a slight kink is evident in the group of municipalities with the lowest increase in total lending, and in the case of municipalities without bank access before January 2011. There is a positive slope in employment, indicating an increase in employment over the period 2011-2013.

An alternative approach to interpreting this result is to create plots of GDP and employment against total lending, after controlling all variables for controls and fixed effects. I perform this analysis exclusively on the set of municipalities with existing bank presence before January 2011.[38] Figure 1.7 displays these plots, revealing no relationship between GDP and total lending. Regarding employment, although there appears to be a slight positive slope for the fitted line, it is so marginal that I can conclude that the relationship is virtually nonexistent. This further aligns

[38]I conduct this analysis for municipalities that experienced bank entry only after January 2011 separately. Those results are presented in Appendix A.2.2, Figure A.5. There seems to be no positive relationship between GDP and the increase in total lending, but a slightly positive relationship in the case of employment. However, since the number of those municipalities is small, their further examination is necessary before making any conclusions.

with observations derived from the plots illustrating the evolution of GDP and employment across binned municipalities.

## 1.7 Robustness Checks

In this section, I investigate several potential explanations for the puzzling result that increased lending had a very negligible effect on economic activity. I examine different channels through which the effect could have materialized.[39]

### 1.7.1 Monopolized Markets

First, I examine a specific subset of municipalities - those "monopolized" by either public or private banks. In my sample, there are 1,183 such municipalities. Among them, 748 municipalities are "monopolized" by public banks, meaning they have access only to branches of either *Banco do Brasil* or *Caixa Economica Federal* or both. On the other hand, there are 435 municipalities where only branches of private banks operate.

To provide a more detailed breakdown, the majority of these municipalities are actual monopolies, with 1,112 out of 1,183 falling into this category. Breaking down individual banks, BB stands out as the most significant monopolist, with 689 municipalities in which it is the only bank that operates. Three private banks follow - Bradesco in 169 municipalities, Itau in 160, and Santander in 81. CEF operates as a monopolist in only 13 municipalities, speaking to its tendency to operate in markets with access to other banks. This is particulalry relevant considering CEF's extenisve entry into markets following the policy introduction, indicating that CEF entered markets already served by other bank(s).

This subset of municipalities could be of interest because, in these markets, individuals and/or firms have limited options for obtaining credit, usually having to rely on a single bank. Consequently, a relationship may develop between the bank and the borrower. This relationship-building

[39] In addition to considering monopolized markets and aggregating the effects across neighboring municipalities, I also conduct the analysis of effects in various sectors of the local economies - tradables and non-tradables (see Appendix A.2.3), and agriculture (see Appendix A.2.4).

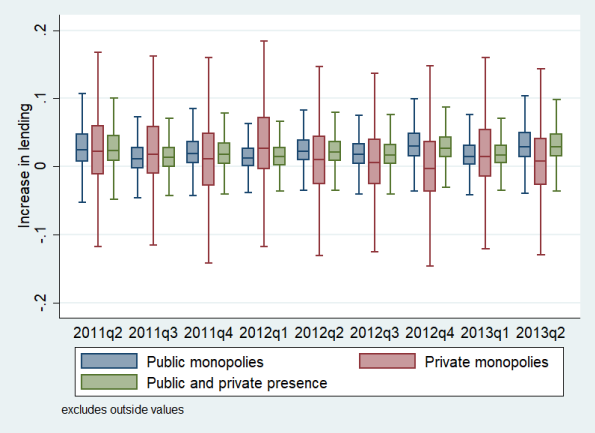



Figure 1.8: Growth of total lending

Notes: Blue boxes represent municipalities in which only branches of public banks were operating, while red boxes represent municipalities that were "monopolized" by private banks. Green boxes show growth of total lending in municipalities where both public and private banks were operating.

process could involve the bank gaining a better understanding of the client and implementing improved screening procedures. Simultaneously, the borrower may establish credibility, facilitating easier access to additional loans. As a result, these relationships could result in the issuance of loans to higher-quality clients, who, in turn, employ the funds more productively.[40,41] Furthermore, this context of monopolized municipalities helps address concerns related to competition between public and private banks driving the results I obtained in the previous section.[42] Therefore, it is plausible that there could be a different response in economic activity to an increase in total lending in these municipalities.

Figure 1.8 shows the growth rate of total lending in municipalities where only public banks operate, those that are "monopolized" by private banks, and compares it to municipalities with a presence of both public and private banks. The figure reveals that the growth rate of total lending was comparable in municipalities "monopolized" by public banks and those with a mix of public

[40]This could be an interesting question on its own. However, to answer such question, there is a heavy data requirement on individual credit contracts that would allow for observing creation of relationships between a bank and a borrower.

[41]Chodorow-Reich (2014) empirically documents the importance of banking relationships in the U.S.

[42]I previously discussed that I do not observe that competition for customers between public and private banks intensifies following the government intervention. However, my analysis is silent on different aspects in which those banks can compete, for example, interest rates on their loans. Given that I do not have data on interest rates, I cannot pursue explaining this aspect of bank competition.

| | GDP | | | | | |
|---|---|---|---|---|---|---|
| | both | | public | | private | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| log(TL) | 0.0099** | 0.0095* | 0.0251* | 0.0274** | 0.0078 | 0.0067 |
| | (0.0048) | (0.0050) | (0.0129) | (0.0132) | (0.0050) | (0.0052) |
| log(TT) | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y |
| N | 3,100 | 3,039 | 1,934 | 1,886 | 1,166 | 1,153 |
| | Employment | | | | | |
| | both | | public | | private | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| log(TL) | 0.0363* | 0.0364* | -0.0054 | -0.0067 | 0.0424* | 0.0413* |
| | (0.0219) | (0.0217) | (0.0211) | (0.0216) | (0.0249) | (0.0240) |
| log(TT) | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y |
| N | 3,091 | 3,040 | 1,925 | 1,887 | 1,166 | 1,153 |

Table 1.9: Effect of increase in total lending on GDP and employment looking at monopolized markets

Notes: *both* refers to specifications where I used all "monopolized" municipalities in the analysis, irrespective of whether a municipality had presence of only public or private banks. Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

and private banks. This suggests that the observed results are not driven by disparities in changes in total lending, as these changes exhibit similar patterns in both types of municipalities. In contrast, municipalities "monopolized" by private banks display higher variability in the change

in total lending.

The results of the regression analysis are presented in Tables 1.9 and 1.10. In the first set of findings, I consider a municipality "monopolized" if only one type of bank operates in it.

I conduct the analysis without distinguishing whether the monopoly is held by public or private banks (sub-column referred to as 'both' in Table 1.9), but also splitting the sample into municipalities exclusively served by one type of bank. Despite the negligible effect on economic activity across specifications, some interesting facts are worth noting.

In the full sample, a 1% increase in total lending corresponds to a 0.0047% increase in GDP. This effect is magnified when the analysis focuses on "monopolized" municipalities. Particularly noteworthy is the finding that this effect becomes five times larger when I exclusively consider municipalities with access to public banks. This suggests a potential significance of public bank presence for local economic activity.

I redo the analysis by restricting the sample to pure monopolies, that is, municipalities where only branch(es) of a single bank are present. The results of this regression analysis are presented in Table 1.10. Sub-column 'all' refers to estimation where I pooled all municipalities that are pure monopolies. Additionally, I emphasize regression that I conducted for BB and Itau, as estimates are different for these municipalities relative to those where other banks are monopolists.

The results are the same, with the effect continuing to be negligible. Interesting to note is that, when considering all monopolized municipalities or those monopolized by a public bank, the estimates are attenuated compared to the previous set of results where I only distinguish whether a municipality is "monopolized" by a public or private bank. However, due to the limited number of "monopolized" municipalities where both BB and CEF are present, I am unable to further explore this difference in results.

Finally, the results for monopolized markets provide suggestive evidence that supports my earlier findings that the competition between public and private banks over customers does not intensify following the government intervention. If there were indeed competition over customers between public and private banks, it might be the case that in those markets, banks might issue

| | GDP | | | | | |
|---|---|---|---|---|---|---|
| | all | | BB | | Itau | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| log(TL) | 0.0082* | 0.0075 | 0.0185* | 0.0204* | 0.0688 | 0.0665 |
| | (0.0046) | (0.0048) | (0.0110) | (0.0113) | (0.0526) | (0.0523) |
| log(TT) | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y |
| N | 2,907 | 2,854 | 1,787 | 1,744 | 465 | 460 |
| | Employment | | | | | |
| | all | | BB | | Itau | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| log(TL) | 0.0082* | 0.0075 | 0.0185* | 0.0204* | 0.0688 | 0.0665 |
| | (0.0046) | (0.0048) | (0.0110) | (0.0113) | (0.0526) | (0.0523) |
| log(TT) | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y |
| N | 2,897 | 2,854 | 1,777 | 1,744 | 465 | 460 |

Table 1.10: Effect of increase in total lending on GDP and employment looking at purely monopolized markets

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

loans that are less productive or extend credit to riskier clients to attract customers. Consequently, a portion of increased lending would be allocated to these unproductive loans, which would not contribute positively to economic activity. However, in the case of monopolized markets, where there is certainly no competition, such concerns are eliminated. Nevertheless, the

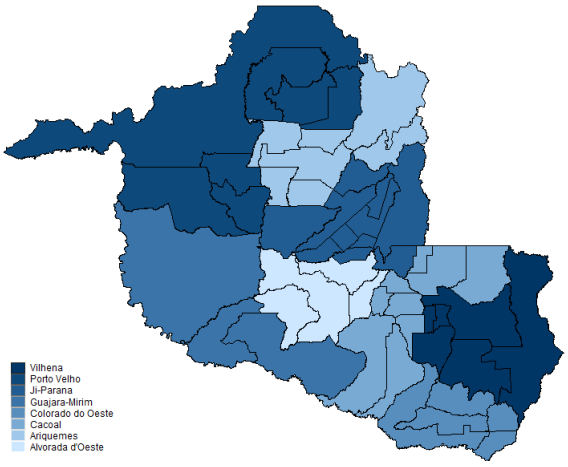



Figure 1.9: Micro-regions - Rondônia

Notes: The map presents administrative division of the state of Rondônia into micro-regions by IBGE. Each of these micro-regions consists of several municipalities sharing economic activity.

effect of the increase in total lending on economic activity remains negligible and comparable to the effect I estimate using the entire sample of municipalities. This suggests that the lack of effects on economic activity is not driven by bank competition for customers.

### 1.7.2 Aggregating Effects across Neighboring Municipalities

Continuing with the exploration of potential explanations for the puzzling negligible effect of increased lending on economic activity at the municipality level, I consider the possibility that the effects might be more pronounced at a higher level of geographical aggregation. This hypothesis arises from the idea that spillover effects across nearby municipalities could contribute to a more discernible impact on economic activity.

To illustrate, consider Porto Velho, Nova Mamore and Buritis, three municipalities lying to the west at the Bolivian border. Porto Velho is the capital of State of Rondonia, while Nova Mamore and Buritis are two adjacent municipalities.[43] It could be easy to imagine that a lot of economic activity is shared between these municipalities given how close they are to each other. For example, people who live in Buritis may regularly commute to Porto Velho for work or leisure. Moreover, the mining of cassiterite is the most important economic activity in the region, and Porto Velho is an

[43] As per Brazilian Institute for Geography and Statistics (IBGE), several municipalities including these three constitute a separate area, i.e., micro-region, which is called Porto Velho.

| | GDP | | Employment | |
|---|---|---|---|---|
| | (1) | (2) | (1) | (2) |
| log(TL) | -0.0166 | -0.0189 | -0.0329 | -0.0219 |
| | (0.0224) | (0.0225) | (0.0599) | (0.0567) |
| log(TT) | - | Y | - | Y |
| log(wage) | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y |
| Time FE | Y | Y | Y | Y |
| Micro-region FE | Y | Y | Y | Y |
| N | 1,476 | 1,446 | 1,469 | 1,446 |

Table 1.11: Effect of increase in total lending on GDP and employment (aggregation at micro-region)

Notes: Standard errors are clustered at the micro-region level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

important trading center for it - it is likely that economic activity related to mining is spread across all the municipalities within this micro-region. Therefore, recognizing the potential for spillover effects of increased lending across neighboring municipalities constituting "local economies" is important.[44] For example, there are eight local economies (micro-regions) in the state of Rondonia, as presented in Figure 1.9. In what follows, I want to explore the potential spillover effects across these geographical clusters.

I am using two levels of geographical aggregation of municipalities in Brazil as provided by Brazilian Institute for Geography and Statistics (IBGE) - aggregation to micro-regions as well as aggregation to meso-regions - to investigate potential spillover effects of increased lending. I consider 495 micro regions that are located within 129 meso-regions.[45] I aggregated the data in the following way. First, I begin with the original sample that I used for the analysis, containing municipalities served by the five largest banks only. I augmented those with neighboring municipalities within their respective micro- and meso-regions. This expanded analysis involves calculating the

[44]The definition of these local economies, i.e., micro-regions, resembles the idea of commuting zones in the United States.

[45]Note that according to IBGE there are 558 micro-regions and 137 meso-regions in Brazil.

| | GDP | | Employment | |
|---|---|---|---|---|
| | (1) | (2) | (1) | (2) |
| log(TL) | -0.0295 | -0.0341 | 0.0037 | 0.0081 |
| | (0.0528) | (0.0530) | (0.0820) | (0.0823) |
| log(TT) | - | Y | - | Y |
| log(wage) | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y |
| Time FE | Y | Y | Y | Y |
| Meso-region FE | Y | Y | Y | Y |
| N | 387 | 381 | 385 | 381 |

Table 1.12: Effect of increase in total lending on GDP and employment (aggregation at meso-region)

Notes: Standard errors are clustered at the meso-region level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

overall increase in total lending at the regional level, taking into account all bank branches in each region, not just those of the five largest banks. Subsequently, I aggregate outcome and control variables at the regional level, such as regional GDP, employment levels, and average wages.[46]

First, I present the results of the analysis aggregated at the micro-region level in Table 1.11. Despite accounting for potential spillover effects between closely neighboring municipalities, the results remain negligible.[47]

Aggregating the analysis to the meso-region level does not significantly alter the results, as the estimated effects remain negligible. The results of this analysis are presented in Table 1.12.

## 1.8 Effects on Deposits

Another possibility is that the additional funds that were made available by the increase in total lending ended up as deposits in banks. This hypothesis suggests that households and firms, taking

[46] Another possibility is to calculate a weighted average, where I can weight individual wages with municipality population or employment level. However, I do not believe this will change the results substantially.

[47] The coefficient of interest even has a negative sign, which should reflect that the effect of increased lending was negative on real outcomes. However, given the high statistical insignificance of the coefficient and its very low value in all specifications, I consider that the effect is essentially zero.

advantage of the increased accessibility of loans, chose to secure funds for an uncertain future by depositing the borrowed amounts. Alternatively, borrowers who could secure loans under more favorable conditions post the government intervention might have utilized this opportunity to repay their debts, placing the difference into deposit accounts.[48] In this section, I examine this possibility.

Here, I present the results of the regression analysis, where I estimate the following regressions:

$$\frac{dep_{m,t}}{GDP_{m,2011}} = \beta \times \frac{TL_{m,t-1}}{GDP_{m,2011}} + \left( \sum_{q=2}^{5} \beta_q \times \frac{TL_{m,t-1}}{GDP_{m,2011}} \times I_{q,m} \right) + \gamma_1 X_{1,m,t-1} + \gamma_2 X_{2,m,y-1} + \mu_m + \mu_t + u_{m,t} \tag{1.7}$$

where the dependent variable is the deposits in municipality $m$ at month $t$ normalized by the municipality's GDP from 2011.[49] The explanatory variable is total lending in month $t-1$ within the same municipality $m$, also normalized by GDP from 2011. Additionally, control variables are incorporated to account for increased spending ability (i.e., increased demand) that could potentially be saved into deposit accounts. These controls include the total government transfer in municipality $m$ at month $t-1$. as well as lagged wage and the GDP index serving as proxies for the wealth of a municipality.

Furthermore, in one specification, I incorporate the term within the brackets from equation 1.7. This term is intended to capture the differences between municipalities based on their income level.[50] For example, I would anticipate that households and/or firms in the poorest municipalities demonstrate a more pronounced effect of lending on deposits, indicating that borrowers in these municipalities are more inclined to leverage easily accessible credit to take loans and save for the future. This term involves the interaction of deposits with the indicator variable $I_{q,m}$, equal to 1 if municipality $m$ is in the $q-th$ quintile of the income distribution.

Results from specifications (1) and (2) in Table 1.13 support the possibility that a significant portion of increased lending ended up in deposit accounts. The estimates indicate that, on average,

[48] In its issue from October 2012, FGV IBRE Macro Bulletins provide information about reductions in interest rates and bank spreads allowing for debt renegotiation, that will result in adjustments of household budgets.

[49] I choose to "homogenize" the variables dividing through by the fixed municipality level GDP from the period before the policy was introduced.

[50] As a measure of municipality's income, I use the pre-policy GDP at the municipality level. Based on this measure, I split municipalities in the sample into income quintiles.

| | $\frac{dep_t}{GDP_{2011}}$ | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\frac{Lending_{t-1}}{GDP_{2011}}$ | 0.227*** | 0.236*** | 0.325*** |
| | (0.006) | (0.006) | (0.011) |
| $\frac{Lending_{t-1}}{GDP_{2011}} \times I_2$ | | | -0.087*** |
| | | | (0.014) |
| $\frac{Lending_{t-1}}{GDP_{2011}} \times I_3$ | | | -0.136*** |
| | | | (0.016) |
| $\frac{Lending_{t-1}}{GDP_{2011}} \times I_4$ | | | -0.040** |
| | | | (0.021) |
| $\frac{Lending_{t-1}}{GDP_{2011}} \times I_5$ | | | -0.160*** |
| | | | (0.005) |
| TT | - | Y | Y |
| wage | - | Y | Y |
| GDP | - | Y | Y |
| Time FE | Y | Y | Y |
| Municipality FE | Y | Y | Y |
| N | 62,748 | 61,623 | 61,623 |

Table 1.13: Effect of increase in total lending on deposit creation
Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

out of R$1,000 in new lending, R$230 ended up in deposit accounts.[51]

Specification (3) highlights variation in responses across municipalities with different income levels. I omit the lowest income group, so that I can use it as a reference group. The results indicate that in municipalities constituting the lowest income group, the effect of increased lending on deposits was the strongest and significantly different from all other, wealthier municipalities. This aligns with the notion that, in municipalities that were most financially constrained, the borrowers were saving greater portions of funds obtained through loans for future use.

Despite the considerable reduction in interest rates in response to the policy, as documented in

[51]Evaluating results of regressions in logarithms at the mean values for lending and deposits, I obtain that newly originated lending amounting to R$1,000 leads to approximately R$290 in new deposits. This indicates similar effects as the analysis in levels.

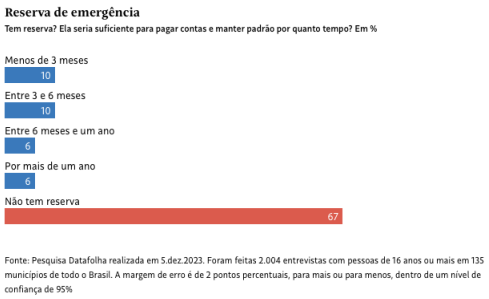



Figure 1.10: Household emergency reserves

Notes: Results of a survey carried out on December 5, 2023. 2,004 interviews were conducted with people aged 16 or over in 135 municipalities across Brazil. The error margin is +/-2 p.p. with a 95% confidence level.
Source: Datafolha

Joaquim et al. (2023), this result remains striking, considering that obtaining funds through loans is relatively expensive in Brazil.[52] Two facts reinforce the conclusions of the analysis. Firstly, the results are not counterintuitive, showing that the largest portion of loans was saved in the poorest municipalities. Moreover, a survey conducted by the research institute Datafolha, presented in Figure 1.10, indicates that two-thirds of the population is struggling with paying bills and maintaining their standard of living, lacking savings for emergencies. This suggests that people might be taking out loans to cover living expenses and save some money, especially during periods when loans are easily accessible.

Results showing that a significant portion of loans were saved in deposit accounts might have different potential explanations, opening the door for several avenues for future research.

First, the question arises if there are any structural differences between the clientele of public and private banks. In Figure 1.5, I observe a smaller increase in lending in higher-income municipalities following the credit expansion. Additionally, the discussion of trends in loan origination from section 5 shows that increase in lending is mainly coming from public banks. Combining these two observations, I conjecture that customers of public banks are lower-income compared to clients of private banks. If this is indeed the case, it would further reinforce the conclusions of this section, as it would not be surprising that lower-income customers take the opportunity to get

[52] Without further examination of the specifics of loan conditions, particularly with respect to interest rates, it is challenging to assess how expensive this form of financing future consumption/investment actually was. To answer this question, I would at least require data on interest rates charged by bank branches, which I do not have access to.

loans at the moment of their increased availability to save the funds for future use.

The second question, which is somewhat related to the first one, is whether households and/or firms obtaining loans from public banks after the government intervention, were able to access credit before the policy. This would tackle concepts of borrower quality and the bank screening process. However, addressing this question would entail significant data requirements, as it would require insights into the entire universe of individual loan applications.

Finally, worth mentioning is the possibility that borrowers may have used the loans that became available to them after the policy to repay older debts that did not go through the system. Investigating this question would, however, require data on household and firm debt from all possible sources, both official and unofficial.

## 1.9 Conclusion

In this paper, I investigate how the Brazilian government policy implemented March 2012, aimed at increasing credit supply, impacted competition in the banking sector and economic activity. Using a data set containing information on individual branches of Brazilian banks, I first document that public banks adhered to the intervention and expanded their credit supply. This resulted in an overall increase in lending, as the expansion in public bank lending did not significantly offset that of private banks. Furthermore, by using deposit data as a proxy for a bank's clientele, I do not observe that competition for customers intensifies following the implementation of the policy.

However, it is important to note that there is ample room for further research regarding the implications of the policy for competition in the banking sector. First, employing detailed information about the customer base of each branch would allow for tracking movements of customers between banks, providing a deeper understanding of competition over customers. Second, competition for customers represents only one dimension across which banks can compete. Equally, if not more, important is competition on loan conditions, particularly interest rates. This form of competition can have significant implications for loan issuance, including the amounts and types

of loans. As the government aimed to promote lending through this policy, understanding if the policy stimulates interest rate competition between public and private banks across various loan categories would be of great interest. However, as data on interest rates charged by individual branches is not available, I cannot explore this important avenue for research at this time.

After establishing that the policy led to increased credit supply, I move on to examine the implications of increased lending for economic activity. I perform a series of panel data regressions with various economic outcomes as dependent variables, controlling for credit demand to address the endogeneity of total lending. I find a negligible effect of the policy on economic activity, at least within the short-term focus of my analysis. Following the estimation of a negligible impact on GDP and employment at the municipality level, I conduct a series of robustness checks, exploring different channels through which the effect could have materialized. These robustness checks confirm the initial result that economic outcomes were not affected in the short term. However, I find that borrowers saved a substantial amount of money, taking loans when funds were easily obtainable and saving them for future use. This suggests that the effects of the policy may be spread across a longer period of time.

It may be argued that other loan terms, especially interest rates, are important to consider when estimating the effects of the government policy. While the data I use does not provide information on interest rates and other terms of loans, the impact I measure is so small that the richer data is very unlikely to overturn the findings.

Several important questions arise from the puzzling lack of effects of the policy on economic activity. Firstly, it would be interesting to understand the demographics of customers for public and private banks. The analysis I conduct suggests that public banks attract lower-income customers. With data about characteristics of borrowers and depositors at each branch, we could gain a deeper understanding. This, in turn, could provide insights to the client structures of public and private banks differ and what implications these differences have for the types of loans issued, their utilization, default rates, etc. This prompts another avenue for research, understanding if customers obtaining loans from (public) banks post-policy were unable to secure credit before the

policy. Besides shedding light on the structure and productivity of issued loans, this setting allows for the study of default rates, borrower quality, the bank screening process, and adverse selection problems in general. Furthermore, future research should address potential effects this policy had on economic activity in informal sectors of the Brazilian economy. However, as I lack access to necessary data to study these questions, I leave them for future research.

# Chapter 1: Bibliography


[1] Bazzi, S, Muendler, M., de Freitas Oliveira, R., Rauch, J. E. (2023): *Credit Supply Shocks and Firm Dynamics: Evidence from Brazil*. Centre for Economic Policy Research, Discussion Paper DP18503.

[2] Chodorow-Reich, G. (2014): *The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis*. The Quarterly Journal of Economics, 129(1): 1–59.

[3] Coelho, C. A, De Mello, J. M. P., Rezende, L. (2013): *Do Public Banks Compete with Private Banks? Evidence from Concentrated Local Markets in Brazil*. Journal of Money, Credit and Banking, 45(8): 1581–1615.

[4] Coleman, N., Feler, L. (2015): *Bank Ownership, Lending, and Local Economic Performance during the 2008–2009 Financial Crisis*. Journal of Monetary Economics, Vol. 71, pp. 50-66.

[5] FGV IBRE (2012): *Boletim Macro IBRE (Outubro de 2012)*. https://portalibre.fgv.br/boletim-macro

[6] Garber, G., Mian, A. R., Ponticelli, J., Sufi, A. (2022): *Consumption Smoothing or Consumption Binging: The Effects of Government-Led Consumer Credit Expansion in Brazil*. NBER Working paper 29386.

[7] Fonseca, J., Matray, A. (2022): *The Real Effects of Banking the Poor: Evidence From Brazil*. NBER working paper 30057.

[8] Imbens, G. W., Newey, W. K. (2009): *Identification and Estimation of Triangular Simultaneous Equations Models Without Additivity*. Econometrica, Vol. 77, No. 5, pp. 1481-1512.

[9] Jimenez, G., Peydro, J., Repullo, R., Saurina, J. (2019): *Burning Money? Government Lending in a Credit Crunch*. Working paper.

[10] Joaquim, G., Netto, F., Haas Ornelas, J. R. (2023): *Government Banks and Interventions in Credit Markets*. Working paper.

[11] Sanches, F., Silva Junior, D., Srisuma, S. (2018): *Banking Privatization and Market Structure in Brazil: A Dynamic Structural Analysis*. The RAND Journal of Economics, Vol. 49, No. 4, pp. 936-963.

[12] Sapienza, P. (2004): *The effects of government ownership on bank lending*. Journal of Financial Economics, 72(2): 357–384.

[13] Schmitz, E. E. (2020): *Effects of State-Owned Banks' Programs to Stimulate Credit: evidence from Brazil*. BCB Working Paper Series 519.

# Chapter 2: Television Introduction and Agricultural Production

## 2.1 Introduction

Technological progress and inventions can, and usually do, have effects on many industries, and not just in those where they were introduced. History witnessed a great number of such spillovers. For example, the development of the steam engine led to huge effects in many industries, contributing to the Industrial Revolution. However, inventions can have indirect effects as well. For example, the invention of the printing press allowed for easier storage and diffusion of knowledge.

In this paper, I try to empirically assess the value of the improved quality of information, where the improvement in quality is due to an external factor: the introduction of television in the U.S. in the period 1940-1960. As I argue later, the entry of TV allows for an alternative way of presenting weather information to farmers. The advantage of television, compared to newspapers and radio, with respect to this is that the TV allows for a visual presentation of expected weather conditions. Thus, it may have become easier for farmers to understand and process weather information that is displayed to them visually, rather than through a written word or orally. Since information on expected weather conditions is quite important in agriculture, farmers would have been able to make better decisions, and adjust their activities in a way that enhances yields.[1]

Using the data on television introduction and corn production, I find that there is a significant effect of improved quality of information on agricultural outcomes. When I consider the improvement in quality to be simply due to availability of television, the entry of TV leads to an increase in production of corn of between 0.55 and 0.63 percentage points on average. On the other hand, when I account for the amount of time that television was available in a particular region, I show

[1] As argued later, information on expected weather conditions is highly important for different aspects of agricultural activity. For example, surveys show that crops producers put a lot of emphasis on weather reports when making decisions such as when to plant, whether and when to irrigate, whether and when to apply pest controls, and, finally, when to harvest (Frisvold and Murugesan (2013)).

that the estimated effect of improved information quality on corn production is about 0.065 percentage points per year, on average. With the diffusion of television within a county taking between 8-10 years, this coincides with the result when just availability of television is considered, assuming that the effect is linear. Further analysis shows that these result seem to be robust to alternative measures of TV availability, as well as for a particular subset of regions.

My identification strategy relies on variation in television availability across U.S. counties. As the period 1940-1960 represents the early stage of television introduction, there were substantial differences in availability of television signal between nearby counties. For example, consider Monroe and Morgan, two nearby (but not neighboring) counties in Illinois. As Monroe is a neighboring county of St. Louis, Missouri, it experienced the entry of television early, being reached by the broadcasting signal in 1947. It has been another six years before Morgan county experienced the entry of television in 1953. Apart from this difference, these two counties are very similar. Specifically, being very close to one another, they likely share the same weather conditions and their soil is of similar characteristics. I use this setup to analyze the effects that the introduction of television had on agricultural activity.

When it comes to the introduction of television, its entry was arguably non-random. In particular, the Federal Communications Commission (FCC) issued broadcasting licenses to TV stations in order to maximize the number of people that will be reached by the TV signal. Additionally, the profitability of early television was highly dependent on advertising revenues. Therefore, the first applications for broadcasting licenses came from the TV stations located in wealthiest cities, since operating a TV station was most profitable in those regions. Once the TV station was set up in a particular city, it was broadcasting over a wide region and the signal was reaching heterogeneous areas. For these reasons, I argue that the introduction of television was exogenous to agricultural activity.[2]

Another concern is that farmers could not use this method to inform themselves about the

[2]Additionally, two external events caused unexpected delays in television entry: World War II and 1948-1952 FCC-freeze on issuance of new broadcasting licenses. These external events introduced a quasi-random variation in the timing of TV entry.

weather if the diffusion of television was slow. To put it differently, pure availability of the television signal in a county is not enough for the mechanism to work. This concern is mitigated because there was a rapid diffusion of TV in counties reached by a TV signal, as shown in the data, especially during 1950s. Due to the mass production of TV sets at the time, households experienced a quick penetration of television into their homes, Hence, there was a huge variation in viewership across different areas in the United States during this period. In addition to this, survey data shows that, among those households with access to television, viewership surpassed four and a half hours per day by 1950.[3] This additional evidence speaks in favor of the identification strategy used.

Given this quasi-randomness in the entry of TV, I use a difference-in-differences approach to estimate the effect that improved quality information had on agricultural activity. I define the treatment in two different ways. First, I consider a county to be treated as soon as the TV signal reaches that particular county. Second, I consider the number of years the TV signal was available in a particular county to account for the "intensity" of treatment. Arguably, a household needs to own a TV set to start enjoying the benefits of television. For this reasons, I also consider alternative definitions of the treatment variable, in which I take a county as treated only after the share of households owning a TV set has crossed a threshold. Also, I conduct the analysis for a certain subset of counties that belongs to so called "corn states", that is, states that contribute more than 90% of yearly corn production in the United States. My results seem to be robust across different specifications.

**Literature review.** This paper contributes to the strand of the economic literature that studies what are the effects of television introduction on various outcomes, and tries to explain the economic mechanisms through which television affected those. Gentzkow (2006) started this literature by collecting historical data on television introduction in U.S. from various issues of *Television Factbook*. He studies the effect on voting behavior of individuals. The main finding is that there is a significant decrease in voter turnout as a consequence of TV introduction. He argues that the mechanism for this effect is the crowding out of (local) political information: TV tends to substi-

[3]For more information on this, see Television Bureau of Advertising (2003).

tute newspapers and radio as a source of news and information for individuals, and the coverage of relevant political information is much lower in the former than the latter type of media. Gentzkow and Shapiro (2008) find evidence that childhood television viewing enhances cognitive and educational development. They argue that this is because watching television crowds out alternative activities that have lower educational value. Angelucci, Cage and Sinkinson (2019) study the effects of television introduction on local newspapers. They find strong evidence that the entry of TV led to a significant decrease in the circulation and advertising revenues of evening newspapers. However, the effect is negligible (and even positive) on morning newspapers, which they argue is potentially due to complementarity between morning newspapers and televised evening news.

The second strand of economic literature this paper contributes to is about the effects and importance of weather forecast information on agricultural activity. Lave (1963) investigates the benefits of better weather information to the raisin industry in California. To evaluate these benefits, he fits a supply curve for the raisin industry. Within a decision theory model, he estimates a $90 value of accurate weather forecasts. This figure corresponds to an additional ton of raisins produced by acre, with an expected value of production per acre amounting to $315. Adams et al (1995) estimate the value of improved long-range weather information to agriculture. They do so in a setting of improved forecasts of quasi-periodic redistribution of heat in the tropical Pacific ocean. The economic value of improved forecasts comes from a Bayesian decision theory framework. They estimate that the value of perfect weather information to agriculture would be about $145 million, representing about 2-3% of the value of total crop production in southeastern United States. Rosenzweig and Udry (2013) consider how rainfall realizations affect the returns on planting-stage investments. They show that farmers' investment decisions are significantly affected by forecasts, and that the response of investment decision is greater the more skilled the forecast is. Additionally, they show that even modest improvements in forecast skill increase average profits substantially. Ziolkowska (2018) studies the value of weather information provided by Oklahoma Mesonet.[4] She estimates that, under certain assumptions, there is a cumulative eco-

[4]It is the largest monitor and provider of environmental and weather information in the state of Oklahoma.

nomic benefit for the period 2006-2014 of $183.1 million for agricultural production in the state from information provided by Mesonet. She argues that this estimated effect is mostly attributable to prevented losses, especially during drought years. As a reference, the extreme drought in 2012 resulted in agricultural production losses of $400 million.[5] In a related study, Ziolkowska and Zubillaga (2018) estimate that the median economic value of information provided by Mesonet is $1000 per farm per year.

The rest of the paper is organized as follows. In Section 2, I describe the data, the sources from which it was collected, and present summary statistics. Section 3 provides background on television introduction, and agricultural activity, as well as the importance of weather information in agriculture. In Section 4, I describe the empirical strategy used to estimate the effect of improvements in quality of information on agricultural activity. Section 5 presents and discusses main results of the paper, while Section 6 discusses several robustness checks. Finally, Section 7 concludes.

## 2.2 Data

In this section, I describe the data that I will be using in this study, and I provide summary statistics.

### 2.2.1 Data on Television Introduction

I use data on television introduction and availability that was collected and made publicly available by Gentzkow (2006). These data were compiled from different editions of *Television Factbook* (and *Television Digest*), which is a yearly data book about the television industry. The book contains a profile about each station in the U.S. that was operating at the time: in particular, location of the station, strength of its signal, and starting date.

However, this data does not provide directly the geographical regions in which television signal was available. To overcome this problem, I use Designated Market Areas (DMAs). Then the

[5] Agricultural sector in Oklahoma generated $3.8 billion in net value added in 2015. See *Oklahoma Agriculture Statistics 2015*.

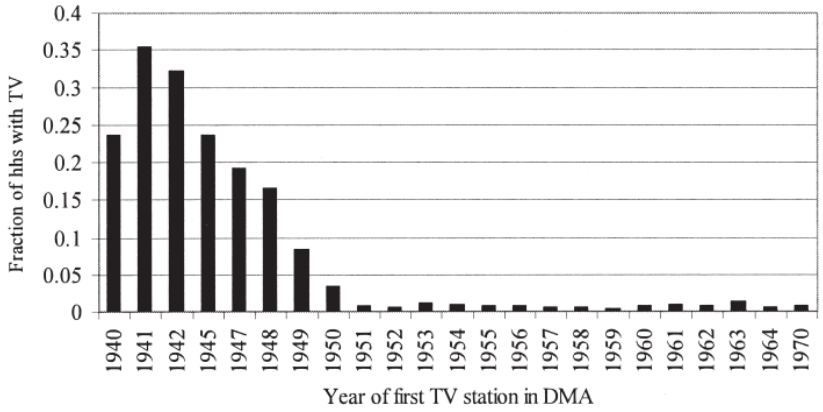



Figure 2.1: 1950 Television Penetration by First Television Year
Source: Gentzkow 2006

availability of television signal in a particular DMA was matched to the location and starting date of broadcasting from the historical data. Since every county in the U.S. is assigned to one DMA, in this way, information on the year at which television became available in every county was obtained.[6] More precisely, the year in which a particular DMA is considered to have experienced the introduction of TV is the year in which at least one station broadcasted for at least four months.

It is important to note that the DMA definitions used are as of 2003. This may be problematic if they do not overlap with areas reached by the broadcasting signal in 1940s and 1950s. To put it differently, the measure of when a county experienced television introduction could be (even substantially) imprecise. In order to address this concern, one can look at the average share of households that owned a TV set at a particular point in time. As Figure 2.1 shows, in 1950 there was a substantial variation, ranging from a bit below 5% to as large as 35%, in the proportion of households owning a TV in DMAs that have already experienced television introduction. On the other hand, the average proportion of households with TVs in counties that belong to DMAs which obtained access to TV only later was below one percent. This provides evidence that, although it is not a perfect measure, the DMA definitions as of 2003 approximate the regions that had access to television in 1940s and 1950s well.

Additionally, data on the number of households owning a TV set by county is available for

[6]There are several counties that are split between multiple DMAs. In these situations, a county is assigned to the largest DMA.

the period 1950-1960. Data is collected form the U.S. Census for 1950 and 1960, while for the other years it was compiled from other sources. Having this data is helpful in understanding the diffusion and growth of television once it became available.[7] Specifically, in this study, I will be using this information in order to conduct robustness analysis.

### 2.2.2 Data on Agricultural Activity

I collected the data about agricultural activity from National Agricultural Statistics Service (NASS), which is a part of United States Department of Agriculture. More precisely, I collected the data from the archives of Censuses of Agriculture conducted by NASS in the past. This data is publicly available on the NASS website. This data is organized in the form of tables, in documents that represent scans of books that contain information from Censuses.

The Census of Agriculture is conducted every five years, in years ending with 4 and 9.[8] Starting 1934, Census of Agriculture reports agricultural activity split by U.S. counties. Hence, from that year onwards, Censuses provide a substantial amount of detailed information about various variables. A Census includes information about: agricultural characteristics of each county (number and average size of farms, land in farms according to use, value of land and buildings), farms split by color and tenure of the operator, information about specified crops harvested, information on livestock and livestock products, information on farm labor and use of commercial fertilizer, etc. These are presented on a county level either as totals or as averages.

Given that, as it will be argued in the next section, the weather information is highly relevant for crops producers, I concentrate on information that is provided about crops harvested. For the purpose of this study, I collect data on corn that is harvested for grain during the 1934-1964 period. I choose corn that is harvested for grain, since for only for this category of corn, the information is provided about total yearly corn yield.

[7] More details on the diffusion and penetration of television is presented in Appendix B.1.

[8] Note that, on the website one can see that Censuses were conducted in the following years: 1935, 1940, 1945, 1950, 1954, 1959, and so on. However, examination of the content of these reveals that the Censuses before (and including) 1950 contain relevant information about agricultural activity for the prior year. For example, looking at the corn yield in the 1940 Census reveals that this year is reported for 1939.

Panel A: *General Characteristics*

| | Mean | Standard deviation | *N* |
|---|---|---|---|
| Corn yield (in bushels) | 927,383.9 | 1,824,362 | 19,946 |
| Farm size (in acres) | 24,336.22 | 33,692.97 | 19.933 |
| Number of farms | 1,092.335 | 1,942.093 | 19,946 |

Panel B: *Averages across Years*

| Year | Corn yield | Farm size | *N* |
|---|---|---|---|
| 1934 | 251.24 | 17.24 | 2,861 |
| | (412.24) | (63.70) | |
| 1939 | 502.86 | 22.82 | 2,888 |
| | (1439.17) | (245.83) | |
| 1944 | 679.20 | 22.77 | 2,888 |
| | (1134.42) | (33.03) | |
| 1949 | 694.12 | 21.11 | 2,899 |
| | (889.32) | (22.38) | |
| 1954 | 766.27 | 23.61 | 2,845 |
| | (4060.08) | (27.34) | |
| 1959 | 1330.97 | 29.98 | 2,830 |
| | (1892.88) | (45.41) | |
| 1964 | 1651.12 | 30.94 | 2,735 |
| | (2315.52) | (41.61) | |

Panel C: *Statistics for Treatment vs Control Group*

| | Treatment group | Control group |
|---|---|---|
| Average corn yield | 1217.91 | 522.75 |
| | (1760.55) | (1144.52) |
| Average farm size | 27.48 | 21.21 |
| | (37.03) | (131.57) |
| *N* | 8,891 | 11,055 |

Table 2.1: Summary Statistics for Corn Production

Notes: Panel A presents summary statistics for originally collected variables. Panel B shows variation and trends across years for variables defined as *average corn yield* and *average farm size*. Finally, Panel C contrasts summary statistics for the treatment group to those for the control group.

After cleaning the data, my sample contains 19,946 county-year observations.[9] I collected information on the total corn harvested for grain in bushels per county per year.[10] In addition to this, I collect information on the total acreage planted with corn on a county-year level, as well as on the number of farms that take part in this production of corn.[11] Panel A of Table 2.1 presents summary statistics for these variables. It is possible to see that the sample mean for corn yield is around 925,000 bushels, with a substantial dispersion across county-year pairs. The mean area planted with corn is about 24,500 acres, and the mean number of farms producing corn is almost 1,100. Both of these two variables have a high dispersion.

In order to normalize these variables, I divide both the total production and the total area by the number of farms that produce corn. In this way I obtain the *average corn yield*, and the *average acreage* planted with corn. Figure 2.2 shows trends in these two variables for the observational period. Panel A shows that the production of corn grew steadily over the first five periods, before it surged in the last two periods (for an increase of almost 50%, or more than 700 bushels on average). Panel B presents trends in the average acreage planted with corn.[12] It shows that the average farm size was stable in the early periods, with some increasing trend in the last two periods. The same data is presented in Panel B of Table 2.1. While it is more difficult to observe trends by looking at these numbers relative to graphs, Panel B shows that there is substantial variation both in average corn yield and average farm size across these years.

Finally, Panel C presents differences in summary statistics between the treatment and control group.[13] While we can observe that there is some difference in average size of farms between those two groups, the difference in average corn yield is striking. However, this is not a problem for the analysis because the difference-in-differences approach will be used.

[9] I take all county-year observations for which the total amount of corn produced is available. In some instances, this information is not readable, or it is corrected in handwriting. I omit those observations.

[10] In the remainder of the paper, I will refer to corn harvested for grain simply as corn.

[11] While the number of farms reporting is available for all observations for which total corn yield is available, in a handful of cases the information on acreage is missing or non-readable. Since not all regression specifications include this variable, I do not omit observations with a missing value for acreage.

[12] In the remainder of the paper, whenever I use the term *farm size*, I am actually referring to the acreage planted with corn.

[13] Exact definitions of the treatment and control group are provided in section 4.

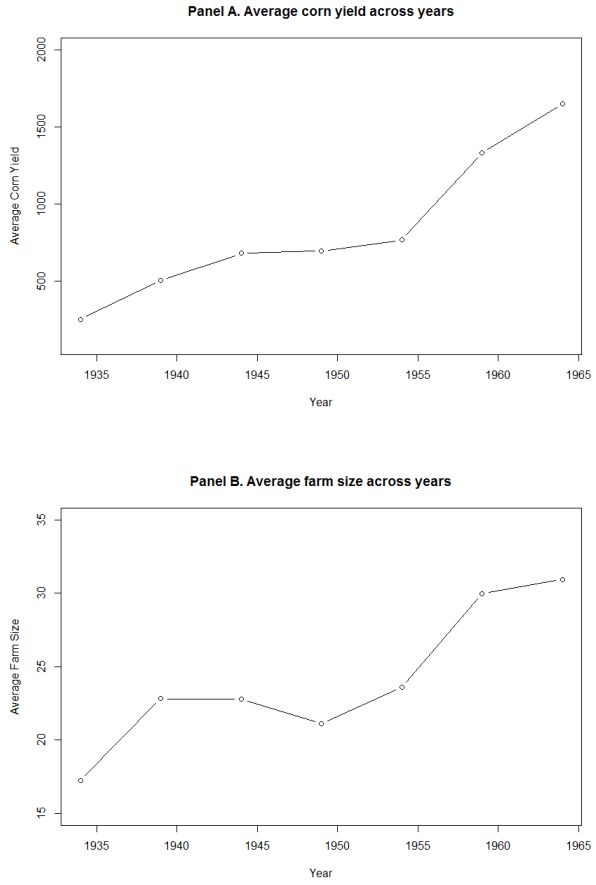



Figure 2.2: Trends in Corn Production and Farm Size

## 2.3 Industry Background

In this section, I present background on the introduction of television in the U.S. as well as on U.S. agricultural production. This should help develop better understanding of the research question that I try to address, and how the empirical strategy presented in the next section works. Moreover, it should help interpret the results I obtain in Section 5.

### 2.3.1 Background on Introduction and Diffusion of Television

Full-scale commercial television broadcasting in the U.S. started on July 1, 1941. This is when the Federal Communications Commission (FCC) granted the first licenses for full-scale commercial broadcasting. Although the television was expected to grow rapidly from that point in time,

there were two events that interfered with the growth of television: World War II and an FCC-imposed freeze on issuing new television licenses in September 1948.

During the World War II, and less than a year since the beginning of commercial broadcasting, the government issued a ban on new television station construction in order to preserve materials for the war effort. This induced a huge slow-down in growth and diffusion of television. The existing stations continued broadcasting, however, no new licenses were issued during the war period. On the other hand, less than 20,000 television sets were in use during the war. Despite the fact that the growth itself was slowed down, there were many technological innovations within the television industry in this period, like better cameras, that, together with technical and logistical aspects that were worked out during the war, were supposed to induce a rapid growth and diffusion of TV in the period after war. As it was argued by Barnouw (1990) once the production of electronic war material stopped, electronic assembly lines were free to turn to production of picture tubes and television sets. Moreover, due to shortages and rationing, consumers accumulated savings.

All this suggested that there would be a rapid growth in television coverage after World War II. In the following years (1946-1948), the FCC granted new permissions for broadcasting, with over 100 of new licenses being issued. In addition to this, by 1950 television signals reached half of the country's population. However, the second event stopped this surge in coverage: in September 1948, the FCC imposed a ban on new licenses due to the poorly designed spectrum allocations. Namely, in some areas there was an excessive signal interference because there was not enough spectrum space left between adjacent markets. Redesigning the spectrum allocation took four years, until finally in April 1952 the FCC lifted the ban and started issuing new licenses. These events, as will be argued later, ensure that the variation in television entry was quasi-random.

The start of the televised weather report was on October 14, 1941. It was shown as part of the news on WNBT (predecessor of WNBC). In the *New York Times* newspaper article from 1996, David Laskin provides a brief overview of the evolution of televised weather reporting in the United States. While the emphasis is on how weather reports were presented in the news (with first presenters being "military veterans [and] tweedy professors of meteorology", continued with

"cartoon characters, stunts ... [and] *weather girls*"), it is possible to infer that weather forecast was extensively present in the television content starting the second half of 1940s. The article also mentions that those reports placed emphasis on visual presentation of weather conditions: presenters were "scrawl[ing] on maps of Plexiglas". Finally, Laskin states that the weather forecast "on many stations ran for a full five minutes", which is a lot compared to today's standards. This provides evidence that the introduction of television indeed offered a new, visual dimension in presenting weather reports to wide audiences.

### 2.3.2 Importance of Weather Information in Agricultural Production

The weather is considered to be one of the most important factors influencing farm production. Weather information is essential for different aspects of farming: it influences crop growth and total yield, determines the necessity of irrigation and pest and disease control, dictates the timing and need for fertilizers, and determines time suitable for fieldwork. For example, information on the expected amount of rain influences the farmer's decision of whether and how much to irrigate. Having access to this information, a farmer would decide not to irrigate, which would save the costs of irrigation, as well as avoid having excess water affecting the crops. Crop growth and crop yield require an appropriate amounts of light, moisture and temperature. Hence, being aware of weather conditions like temperature, humidity and precipitation is necessary for a farmer to protect crops and ensure a high yield. Moreover, certain weather conditions can influence development of pests and diseases, that can have serious adverse effects on crops. For this reason, it would be important for a farmer to be aware of these conditions so that he can decide whether, and also when, there is need to apply pest and/or disease controls. The timing when fertilizers are applied also depends heavily on weather conditions: if these are applied during the rainy periods they would be washed away, leading to unnecessary waste of resources. However, some moisture is required in order that the fertilizer gets worked into the soil. Finally, planning the fieldwork also relies on weather information.

Having forecasts of expected weather can help farmers adapt to expected conditions and mit-

igate the adverse effects of bad weather. Hence, weather information is highly important in agricultural production. For this reason, it is essential that weather information be conveyed to farmers clearly and efficiently. This is also documented in Das et al (2012):

> *[Weather] has a profound influence on the growth, development and yields of a crop, incidence of pests and diseases, water needs and fertilizer requirements in terms of differences in nutrient mobilization due to water stresses and timeliness and effectiveness of prophylactic and cultural operations on crops. Weather aberrations may cause (i) physical damage to crops and (ii) soil erosion. The quality of crop produce during movement from field to storage and transport to market depends on weather. Bad weather may affect the quality of produce during transport and viability and vigor of seeds and planting material during storage.*[14]

Frisvold and Murugesan (2013) conducted a survey among farmers in Arizona, in order to better understand the farmers' requirements when it comes to weather information. They show that about 60% of general agricultural producers emphasized the importance of information on temperature, soil moisture and frost, while more than 40% acknowledged the importance of precipitation, soil temperature, degree days[15] and relative humidity.[16] When it comes to solely crops producers, more than 75% of them consider information about temperature to be important, more than 70% state that information about frost is important, while 65% and 60% claim that information on soil moisture and precipitation, respectively, is important. Finally, about 50% of crops producers emphasize the importance of data availability on degree days, soil temperature and relative humidity. When it comes to usage of this weather information, crops producers use it mostly for decision on irrigation timing (more than 70%), planting timing (about 60%), harvest timing (more than 50%), and pest control timing (about 50%). All this provides further evidence that high-quality weather information is an important factor for agricultural activity.

[14] For more information, see Das et al (2012).

[15] Weather data on degree days is important in making decisions on planting, irrigation, and application of pest control.

[16] Note that for this question participants in the survey could have chosen all off the weather information they consider important.

## 2.4 Empirical Strategy

In this section, I present and explain the regression model I will be using in quantifying the effect of increased quality of information on agricultural production. Before presenting the model, I argue that television introduction is an exogenous and valid variable to use as a proxy for higher-quality information.

### 2.4.1 Exogeneity and Validity of Television Entry

The first concern is that the introduction of television may not be exogenous to the dependent (and other) variables that are examined. That is, the concern is that the entry of TV is in some way related to agricultural activity. For example, it could be that broadcasting occurred first in regions where agricultural activity highly depends on high-quality, comprehensible weather information (regions where floods, droughts, or other extreme weather conditions are more likely). However, this was not the case. Indeed, there was a particular ordering of entry, but this had nothing to do with agricultural activity: the wealthiest and largest cities were the ones to first receive television signals. The objective of the FCC in issuing broadcasting licenses was to maximize the number of people who would be reached by the television signal. On the other hand, stations applying for broadcasting licenses had an objective to reach greater audience in order to maximize advertising revenues. However, the broadcasting strength of signal that was allocated to each licensee by the FCC, allowed TV stations to cover a substantially larger area than just those cities. This means that signals emitted by those TV stations reached a much more heterogeneous group of counties once the broadcasting started. This included many rural counties. Given that agricultural activity happens mainly in rural areas rather than in large cities, this provides some suggestive evidence that the timing of television introduction was exogenous from the perspective of agricultural decisions.

Moreover, the two exogenous events, World War II and the FCC freeze in the period 1948-1952, led to quasi-random variation in television entry in different markets. World War II led to a government-imposed ban on TV station construction, that caused a delay in issuance of new

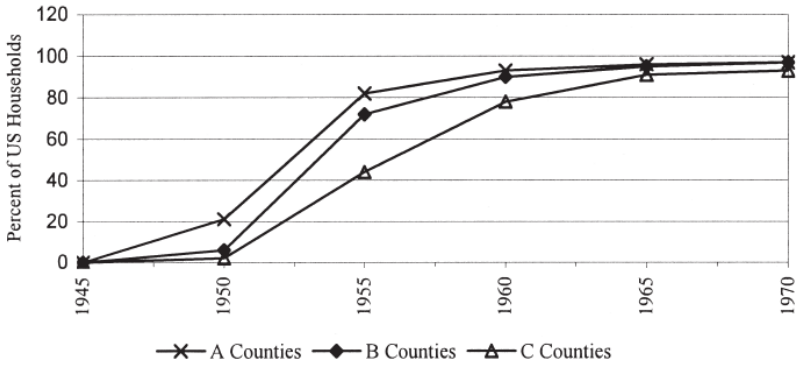



Figure 2.3: Percent of U.S. Households with Television by County Size
Notes: Group A consists of counties in the 25 largest metropolitan areas. Counties with population of more than 150,000, that are not in Group A, constitute Group B. All other counties are in Group C.
Source: Gentzkow (2006)

broadcasting licenses. Furthermore, problems in spectrum allocations caused a freeze in new license issuance for the period 1948-1952. Hence, this further strengthens the argument that, for the purpose of agricultural activity, the timing of television introduction was as good as random.

The second concern is the validity of television introduction variable in addressing the research question. First of all, I would like to emphasize that this study considers the period in which there was a substantial variation in television's availability across counties.[17] This variation was induced by the fact that different counties experienced the entry of TV at different times, both due to the FCC decision to grant broadcasting licenses for different areas at different times, and due to the quasi-random variation in the entry of TV due to the exogenous events. In addition to this, television ownership grew at different speed in different counties, which induced a high variation in the number of households owning a TV. Finally, data from Nielsen surveys shows that the television, since its introduction, played a major role in a daily life of households: by 1950 viewership in those households that possessed a TV surpassed four and a half hours per day.[18]

Figure 2.3 helps strengthen these arguments. It shows that there was a rapid growth in the

[17]In contrast to this, studies addressing more recent periods face the difficulty in having a meaningful variation in television viewership. As Gentzkow (2006) argues "[studies are] using variation over time in the number of stations... However, the impact of the marginal station or cable subscriber on aggregate viewing patterns is likely to be small, making it difficult to detect effects in small samples."

[18]There might be a concern that this television penetration is correlated with some particular individual characteristics. However, as Gentzkow and Shapiro (2008) argue "the diffusion of television ownership was rapid and demographically broad."

number of households that had television over time, in particular form 1950 to 1960. However, this diffusion of television occurred at somewhat different speed in different counties. Moreover, the figure shows that by 1960 there was at least 80% of households owning a TV set in all the counties, while this percentage was quite low in 1950. This suggests a substantial variation in television availability in this period.

Finally, there is some evidence, as mentioned in the part on the background of television introduction, that weather reports were a part of the TV program since the earliest days of the television. Moreover, they relied on visual tools in presenting the weather reports. With previous media, namely, radio and newspapers, such tools were not available.[19] Hence, this provides some argument in favor of the TV introduction variable being a valid proxy for the increase in quality of (weather) information that is available to farmers.

### 2.4.2 Empirical Specification

To examine the effect of higher quality weather information on agricultural production, I use a difference-in-differences approach. The regression model I am using to quantify this effect has the following form:

$$\log Y_{it} = \alpha_i + \tau_{st} + \beta \times Treatment_{it} + \gamma X_{it} + \varepsilon_{it}, \tag{2.1}$$

where $i$ indexes counties, $t$ indexes years, $s$ indexes states. $Y_{it}$ is the outcome variable of interest (corn production), $\alpha_i$ and $\tau_{st}$ are county and state-year fixed effects, respectively, and $\varepsilon_{it}$ is the error term. $Treatment_{it}$ represents the treatment variable, that measures some scale of television presence in county $i$ at time $t$. $X_{it}$ represents control variables that are included in certain specifications. The main coefficient of interest is $\beta$, which measures the effect of higher-quality information. The unit of observation is a county-year pair.

County fixed effects are supposed to account for county-specific characteristics that are con-

[19] One can think of the possibility that weather maps could have been presented in newspapers. However, this would be unlikely given that presenting such maps would require a lot space, and still could not be as efficient as a graphics shown on television.

stant over time, like county's exposure to certain weather conditions (floods, droughts, hurricanes, etc.), or the irrigation systems that are used.[20] State-year fixed effects that are included in some specifications are supposed to pick up characteristics relevant for a state within a year, like soil quality.[21]

The $Treatment_{it}$ variable is supposed to account for the farmers' access to higher quality information, through the fact that visual weather reports became available once the television was introduced. Thus, it could be defined as a binary variable that takes the value one if television program was available in county $i$ at year $t$, and zero otherwise.[22] However, this is not the only way I define the variable $Treatment_{it}$. Following Gentzkow (2006), in some specification I allow this variable to grow linearly over time. It takes the value 1 one year after the first TV station started broadcasting in county $i$. After that, its value grows linearly with the number of years since the television was introduced. Hence, in these specification, the $Treatment_{it}$ variable is effectively the number of years since television was introduced in county $i$ at year $t$. More precisely, the variable is defined as $Treatment_{it} = \mathbb{1}(t \geq t_i^*)(t - t_i^*)$, where $t_i^*$ denotes the year in which television was introduced in county $i$, and $\mathbb{1}(\cdot)$ is an indicator function. The reasoning behind this way of defining the treatment variable is that the impact of television would potentially grow gradually over time rather than being discontinuous and immediate. This might be so because it took time after the television was introduced to diffuse across households. In addition to this, the quantity and quality of broadcasted program increased over time after the initial TV entry.

The dependent variable in all specifications is the (log) average production of corn harvested for

[20] Looking at the "Land Irrigated by Method of Water Distribution" table for 2003 from USDA, NASS, *Irrigation and Water Management Survey*, it is possible to observe that irrigation systems are more state- rather than county-specific. That is, there is always a dominant irrigation system within a state, used by most of the farms. This may call for further examination of the importance of irrigation systems.

[21] Soil quality is an important characteristic for the success of agricultural production, and it can be affected over longer periods by treating the land in a particular way. Given that I observe production for every five years, it is expected that the quality of soil changes over years. Still, it is to be considered whether this is more a county rather than a state characteristic, but one can think of the average state soil quality for the purposes of this study. For more information see Kimme (2012) article *Soil quality information*.

[22] Due to the fact that TV penetration was negligible prior to the end of World War II, I follow the strategy from Gentzkow (2006) and "assign a first television year of 1946 to all counties that had stations before that date" (Gentzkow 2006). This should not really affect the results since the number of counties in question is quite small. However, in one of the robustness checks, I redefine the $Tretament_{it}$ variable to account for the actual timing that television was introduced.

grain. Given that each Census of Agriculture reports the total amount of corn produced in a county within a year (in bushels), I normalize this variable by the number of farms that were producing corn for grain in a particular year. In this way, I obtain a measure that is more comparable between counties. Since this still leaves huge differences between some counties, I take a natural logarithm of the average corn production in order to make this variable more compact.

In essentially half of the specifications, I include the acreage of farms producing corn that is harvested for grain as a control variable. This variable is supposed to control for the simple fact that, for example, increasing the farm area allocated to corn would lead to greater production. In this way I control for the fact that pure size of the farm has an effect on how much corn will be produced within a given year.[23] Since the total acreage in a county within a given year is provided in the Census of Agriculture, I normalize this variable by the number of farms producing corn harvested for grain to obtain the average acreage, and take the natural logarithm of that number. In addition to this, in some specifications I use a dummy variable for 1944, to account for World War II. This is the only year in the data set that falls within the period of World War II, and thus this is the only year dummy variable that I include.

My identification strategy can be illustrated through a simple example. Consider Monroe, Illinois, that saw the TV introduction in 1947, and Morgan, Illinois, that experienced the entry of TV in 1953. Since the television was introduced in 1947, farmers in Monroe had access to the improved information on weather forecast. Hence, starting 1947, I consider Monroe, Illinois, to be treated. In order to estimate the effect that higher-quality information had on agricultural production, one could simply compare the outcome in Monroe prior and after 1947. However, it is expected that other events took place at the time that were relevant for corn production. For example, government may have increased nation-wide subsidies for corn production, leading to a general increase in production of corn.[24] For this reason, I include a control group of all counties

[23]Note that this control is important, but it is only one of many such control variables that should be accounted for. While the area allocated to corn puts some boundaries on how much corn will be produced, capital, labor, and technology used are also important determinants of quantity produced. However, accounting for these controls remains for future research.

[24]Note that subsidies are introduced on the federal level.

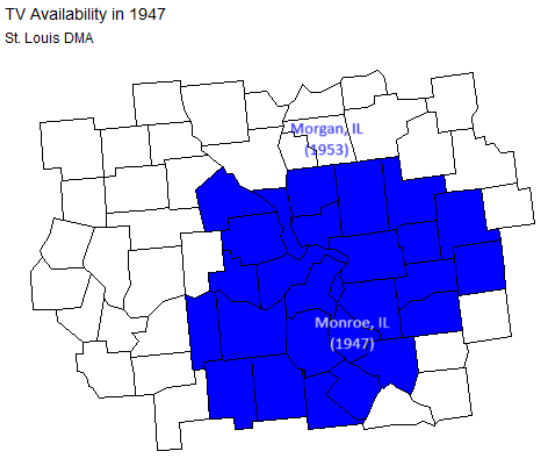



Figure 2.4: TV Availability in Missouri and Illinois Counties around St. Louis
Notes: The map presents IL and MO counties within a 125-mile radius around St. Louis city. Counties comprising St. Louis DMA, that experienced TV entry in 1947, are plotted in blue.

that have not (yet) experienced the entry of TV, that is, that have not (yet) been treated, like Morgan, Illinois. Because of the staggered nature of television introduction, a county remains in the control group until it is treated. Then, the difference in corn production in Monroe before and after 1947 is contrasted to the difference in Morgan before and after 1947. The difference between the two differences is supposed to provide the effect of increase in the quality of information. Identification strategy I use is illustrated in Figure 2.4.

## 2.5 Main Results

In this section, I present the main results of the analysis. First, I present and discuss trends in corn production in the period 1934-1964. Then, I present and discuss results of estimating regression equation 2.1, for two definitions of the treatment variable (i) a variable accounting purely for television availability within a county, and (ii) a variable that takes into consideration the time horizon over which the TV signal was available within a county.

### 2.5.1 Trends in Corn Production

The first evidence that the introduction of television has a meaningful effect on the production of corn can be presented by looking at trends in corn production between different groups of counties. I split all the counties in three different groups. The first group consists of counties in which television was introduced before World War II. Given that the diffusion of television in these counties was relatively slow during the war, we would not expect to see an impact before 1945.[25]

The counties allocated to the second group are those that experienced the introduction of television after World War II, but prior to the FCC-freeze (1946-1948). For those counties, there might be some effect as early as 1949. However, since for a substantial part of them the television was introduced by the end of 1948 and diffused over the following years, we would be more likely to observe the effect from 1954. The last group represents the counties that were the last to experience the entry of TV, after the FCC-freeze was lifted, starting in 1952. Since few of these counties experienced the television introduction in 1952, it should be expected that the effects could not be observed already in 1954. Rather, it would be expected to see the effects of the entry of TV on corn production starting from 1959, to allow for a certain time window for the television to diffuse in those counties.

This is exactly the pattern we observe in Figure 2.5. Panel A shows that, for the first group of counties, there is a kink in average corn production between 1944 and 1949. On the other hand, the production of corn did not seem to experience such kinks in the other two groups at the time. For the second group, presented in Panel B, we can see that the general trend holds by 1954, and the effect is observed only in 1959. This could be due to a somewhat slower diffusion during the years of FCC freeze, so that it actually took time for the effect to develop. Finally, it is possible to observe a kink in corn production for the third group exactly where it was expected. After the FCC-freeze was lifted, and starting in 1953, there was a substantial television entry in the following years, followed by rapid diffusion. Furthermore, more than half of those counties experienced television

[25] Given that the corn production data is available only every five years, this would essentially mean that the effect of TV introduction in those counties would be reflected in corn production in 1949.

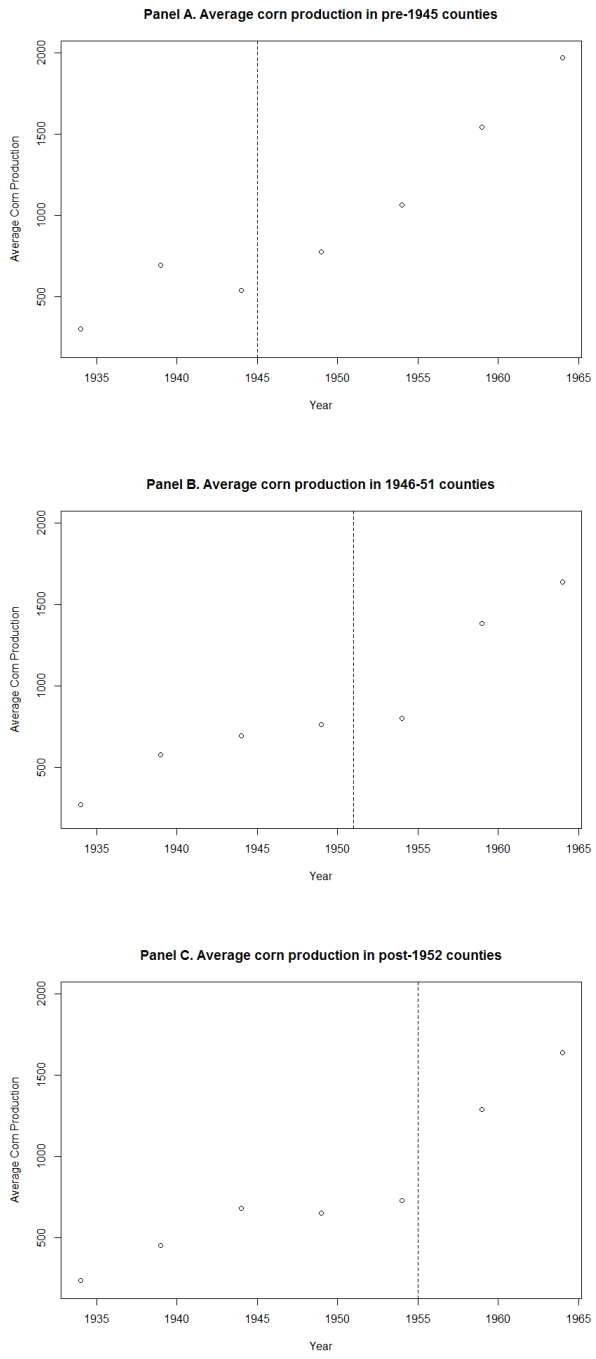



Figure 2.5: Trends in Corn Production Across Different Groups of Counties

entry in 1954 and later. Given these facts, it is expected to see the surge in corn production within these counties between 1954 and 1959, which is exactly the case as presented in Panel C.[26]

[26] Alternatively, it is possible to look at the demeaned trends in corn production. These figures are presented in Appendix B.2.

### 2.5.2 Regression Results

Here, I present main results of the analysis. I split these results into two groups: one that considers a dummy treatment variable, and another in which the treatment variable is suppose to represent the "intensity" of treatment.

In Table 2.2, I present results form specifications in which the variable $Treatment$ is a dummy variable that takes the value of one in years in which television was available in a county, and zero otherwise. Additionally, I use "average acreage of farms" as a control variable in these specifications. The size of the farm is an important determinant of production, since it provides a boundary on how big the yield could be.[27] Specification (2) includes a dummy variable for 1944, that is supposed to pick up the fact that production during this year occurred during World War II.

The effect is sizable, as the estimated coefficient on the treatment dummy is between 0.55 and 0.63. This implies that the production of corn in a county increases by about 0.6 percentage points on average once the television is introduced, and higher-quality weather information becomes available. The coefficient is highly statistically significant.[28] Given that the sample average corn production is around 830 bushels, this implies that the availability of higher-quality weather information leads to an average increase of 6.1 bushels in corn yield.

The other set of results considers an alternative definition for the variable $Treatment$. Specifically, the treatment is defined in a way that it does not only account for the fact that television was available in a county but also for how long it was available. Hence, such defined variable is supposed to account for the "intensity" of treatment.[29] Formally, the variable is defined as $Treatment_{it} = \mathbb{1}(t \geq t_i^*)(t - t_i^*)$, where $t_i^*$ denotes the year in which television was introduced in county $i$, and $\mathbb{1}(\cdot)$ is an indicator function. Defined in this way, the treatment estimates the yearly

[27] Here, it would be important to emphasize that including additional control variables that directly effect corn yield, like labor and capital used, would be desirable. Even more importantly, accounting for technological progress that may have direct effects on cultivating crops would be necessary. This is so particularly because the interplay between size of farm and technology used would be a meaningful control for crop yields. However, this remains for future investigation.

[28] Approximate standard deviation of year-to-year changes in corn yield is 17.65% over the sample period. This makes the estimated 0.6 percentage points increase a small but far from economically insignificant effect.

[29] One interpretation of the intensity of treatment would be that the longer the television was available in a particular county, the more it was diffused among its households.

| | (1) | (2) |
|---|---|---|
| Treatment | 0.55*** | 0.63*** |
| | (0.10) | (0.013) |
| log(average farm size) | 0.80*** | 0.79*** |
| | (0.039) | (0.038) |
| 1944 dummy | | 0.27*** |
| | | (0.016) |
| County FE | Yes | Yes |
| $R$-squared | 0.81 | 0.82 |
| $N$ | 19,933 | 19,933 |

Table 2.2: Effect of Television Availability on Average Corn Production

Notes: Standard errors are clustered by county. Treatment is defined as an indicator variable, taking the value of one in years in which television was available in a county, and zero otherwise. The dependent variable is the natural logarithm of the average corn production. All specification include county fixed-effects. Control variable, *average farm size*, is supposed to control for the fact that larger farms have the potential of growing more corn. Specification (2) takes into account World War II by including a dummy variable for 1944.

contribution of television introduction to corn production.[30]

Table 2.3 shows the results for this treatment variable. Looking at column (1), which is the basic specification, one can see that the effect of the years of television availability on corn production is a yearly increase of 0.065 percentage points on average. This effect is highly statistically significant. To better understand the meaning of this result and make comparison with the first definition of treatment possible, I need to refer to the pattern of television diffusion. As Figure 2.3 presents, it takes between 8 and 10 years for television to significantly penetrate households within a county. With a yearly effect of 0.065 percentage points on average, this amounts to the total increase of 0.52-0.65 percentage points in corn production over the 8-10 years period. Specification (2) shows that accounting for World War II by including a dummy variable for 1944 does not change the results in a significant way.

[30]Note that, defined in this way, the variable treatment assumes a linear effect of TV availability on corn production. Given that the diffusion of television is approximated by an S-shaped curve, it is likely that the effect on corn production is not linear. This alternative possibility is discussed in Appendix B.3.

| | (1) | (2) |
|---|---|---|
| Treatment | 0.065*** | 0.069*** |
| | (0.001) | (0.001) |
| log(average farm size) | 0.77*** | 0.76*** |
| | (0.039) | (0.038) |
| 1944 dummy | | 0.19*** |
| | | (0.014) |
| County FE | Yes | Yes |
| $R$-squared | 0.82 | 0.83 |
| $N$ | 19,933 | 19,933 |

Table 2.3: Regressions of Average Corn Production on Years of Television Availability
Notes: Standard errors are clustered by county. Treatment is defined as *Years since TV introduction* variable, taking the value of one in the first year after the entry of TV in a county, and growing linearly. The dependent variable is the natural logarithm of the average corn production. All specification include county fixed-effects. Control variable, *average farm size*, is supposed to control for the fact that larger farms have the potential of growing more corn. Specification (2) takes into account World War II by including a dummy variable for 1944.

## 2.6 Robustness Checks

In this section, I conduct a series of robustness checks to validate the results I obtained so far. Specifically, these robustness checks can be split into two groups. The first group is concerned with alternative definitions of the treatment variable - I use additional information about TV entry and diffusion to construct alternative measures of TV availability. The second group of robustness checks deals with counties that belong to a specific group of states, usually referred to as "corn states".

### 2.6.1 Alternative Definitions of the Treatment Variable

The first set of main results considered a dummy treatment variable that takes the value one for all years in which the television was available in a county, and zero otherwise. However, the way the TV introduction year was defined set the earliest year of television introduction to be 1946. Yet, there was a particular group of counties (approximately 111 of them) that experienced the introduction of television before 1946. Hence, in the first robustness check, I redefine the variable

| | (1) | (2) | (3) |
|---|---|---|---|
| Treatment | 0.55*** | 0.57*** | 0.63*** |
| | (0.010) | (0.011) | (0.012) |
| log(average farm size) | 0.80*** | 0.79*** | 0.78*** |
| | (0.040) | (0.040) | (0.040) |
| County FE | Yes | Yes | Yes |
| $R$-squared | 0.82 | 0.82 | 0.82 |
| $N$ | 19,933 | 19,928 | 19,888 |

Table 2.4: Regressions of Average Corn Production on Different Definitions of Availability of Television

Notes: Standard errors are clustered by county. Treatment in specification (1) is defined as an indicator variable, taking the value of one in years in which television was actually made available in a county, and zero otherwise. Treatment in specifications (2) and (3) is defined as a binary variable, that takes the value one after the share of households owning a TV set within a county reaches a certain threshold. The dependent variable is the natural logarithm of the average corn production. Control variable, *average farm size*, is supposed to control for the fact that larger farms have the potential of growing more corn.

$Treatment$ by looking at the actual year the television was introduced.[31]

The results for this redefined $Treatment$ variable are presented in the first column of Table 2.4. Specification (1) shows that this alternative definition of treatment does not effectively change the original results, and that the estimated effect is comparable to the estimate presented in column (1) of Table 2.2.

A potential concern with defining the treatment variable relative to the year the television was introduced in a county is that it takes time for the television to actually penetrate a certain fraction of households. While it has been argued that the introduction of television leads to higher-quality information being available to farmers (through higher-quality weather reports), this increase in the quality of information requires that farmers actually own a TV set. Hence, it may be reasonable to consider a county as being treated only after a certain period of time after the television was introduced, since this time delay would allow the new technology to penetrate households. To account for this diffusion process, I redefine the treatment variable in the following way: it is a dummy variable that takes a value of one for all years after the year in which a certain threshold

[31] Treatment remains a dummy variable, however, it takes the value one in all years after the television was actually introduced in a county.

in the number of households owning a TV set is reached in a county, and zero otherwise.[32] In particular, I choose two different thresholds and define two alternative $Treatment$ variables.

First, I choose this threshold to be 20%: after at least 20% of households within a county owns a TV set, that county is considered as treated. Results from specification that include the treatment variable defined in this way are presented in column (2) of Table 2.4. As we can see, there is a slight increase in the average effect of television introduction on corn production compared to the original specifications, 0.57 percentage point increase in column (2) relative to the effect of 0.55 percentage points in column (1) in Table 2.2.

Alternatively, I choose a threshold equal to 45%.[33] In this case, the county is considered as treated as soon as the percentage of households owning a TV set becomes greater than 45%. Looking at column (3) of Table 2.4, it is possible to observe that the effect of the treatment increases once it is defined in this way. The average increase in corn production is 0.63 percentage points on average.

### 2.6.2 Considering Corn States

Although corn is produced across the entire United States, a particular subset of states are considered "corn states".[34] These states account for more than 90% of corn produced in the United States, ranging from a bit more than 1% in Colorado, to about 15% in Illinois, and more than 18% in Iowa. In this part, I restrict the analysis to this particular subset of counties.

Essentially, I conduct the same analysis as in specification (1) of Table 2.2, and specification

[32] It has been argued that the diffusion process was very rapid, particularly in the period after the FCC-freeze was lifted. However, as it was mentioned, it takes a couple of years from introduction of television before a substantial number of households within a county owns a TV set.

[33] Originally, I considered choosing 50% as a threshold. However, closer examination of the data revealed that, in the case of many counties, in one year the percentage of households owning a TV set was slightly below 50%, while in the subsequent year it was already above 60%. This is due to the fact that diffusion happened at high speed, particularly in years after the FCC-freeze was lifted. Hence, I decided to choose a 45% threshold instead.

[34] There is a narrow and wide definition of corn states. In this study, I use a wide definition which includes the following 15 states: Iowa, Illinois, Nebraska, Minnesota, Indiana, South Dakota, Kansas, Wisconsin, Missouri, Ohio, North Dakota, Texas, Michigan, Kentucky and Colorado. I choose to consider the wide definition to have enough observations for the analysis, and, more importantly, to have enough variation in television introduction that would allow me to estimate the effect. Note that this distinction between "corn states" and other states is based on the states' contribution to overall corn production in 2016.

| | (1) | (2) |
|---|---|---|
| Treatment | 0.59*** | 0.066*** |
| | (0.020) | (0.002) |
| log(average farm size) | 0.74*** | 0.72*** |
| | (0.067) | (0.067) |
| County FE | Yes | Yes |
| $R$-squared | 0.78 | 0.78 |
| $N$ | 9,940 | 9,940 |

Table 2.5: Regressions of Average Corn Production on Television Availability for Corn States
Notes: Standard errors are clustered by county. Treatment in specification (1) is defined as an indicator variable, taking the value of one in years in which television was available in a county, and zero otherwise. In specification (2), the treatment is defined as the number of years since television introduction. The dependent variable is the natural logarithm of the average corn production. Control variable, *average farm size*, is supposed to control for the fact that larger farms have the potential of growing more corn. Only a subset of counties that belong to "corn states" is considered.

(1) of Table 2.3. The results of the analysis are presented in Table 2.5. In the first specification, I consider a $Treatment$ as a dummy variable that takes the value one for years after the year in which television was introduced in a county, and zero otherwise. This specification is supposed to resemble specification (1) from Table 2.2, and check robustness of that result. As can be seen from column (1), the introduction of television led to an increase of 0.59 percentage point in corn yield on average for the subset of corn states. This effect is highly statistically significant, and it is somewhat stronger compared to the estimate in the original sample.

In the second specification, I use the treatment variable as it was defined in specifications presented in Table 2.3. Namely, the variable $Treatment$ represents the number of years since the entry of TV in a county. Variable constructed in this way is supposed to account for the intensity of treatment. Estimation results are presented in column (2) in Table 2.5. Column (2) shows that the estimated effect of years since television introduction on corn production is 0.066 percentage points on average for corn states. This effect is highly statistically significant. The effect is quite similar in magnitude to that estimated for the entire sample (column (1) in Table 2.3).

An interesting question is whether there is a statistically significant difference in the effect for counties from corn states relative to those from other states. Some evidence on this is provided

| | (1) | (2) |
|---|---|---|
| Treatment | 0.67*** | 0.54*** |
| | (0.018) | (0.011) |
| Treatment × Corn State | 0.132*** | 0.033** |
| | (0.024) | (0.015) |
| log(average farm size) | | 0.80*** |
| | | (0.040) |
| County FE | Yes | Yes |
| *R*-squared | 0.70 | 0.82 |
| *N* | 19,946 | 19,933 |

Table 2.6: Regressions of Average Corn Production on Years of Television Availability - Differences Between Corn and Non-Corn States

Notes: Standard errors are clustered by county. Treatment is defined as an indicator variable, taking the value of one in years in which television was available in a county, and zero otherwise. *Corn state* variable is an indicator variable that takes the value one if a county in question belongs to a state considered as a "corn state", and zero otherwise. The interaction between the treatment variable and the corn state indicator is supposed to provide evidence on whether the introduction of television affected counties coming from different types of states in a different way. The dependent variable is the natural logarithm of the average corn production. Specifications (2) includes the *average farm size* variable, that is supposed to control for the fact that larger farms have the potential of growing more corn.

in Table 2.6. Specifications presented in this table include the interaction between the treatment dummy variable, and a dummy variable for whether a state is considered as a "corn state". Column (1) shows that there is a difference in the effect from television introduction of 0.13 percentage points between counties in corn states and those in other states. This effect is statistically significant, which suggests that higher-quality weather reports are more important for counties in corn states. Once the average farm size is accounted for, the difference in effect between counties belonging to the two types of states drops to 0.033 percentage points. However, the difference remains statistically significant, though at the 5% level.

## 2.7 Conclusion

In this study, I attempted to assess the value of improved quality of information empirically. I quantify this effect through the perspective of television introduction and agricultural activity. The introduction of television allowed for a novel way of presenting weather information, relative to

what was possible with newspapers and radio. In particular, it allows for a visual presentation that should enhance farmers' understanding of weather reports. Once farmers gain access to television, they gain access to higher-quality information. Thus, I use the entry of TV as a proxy for the improved quality of information. Given that weather information, and its proper understanding, is particularly important for crops producers, introduction of this new medium should lead to better decision-making by farmers, and higher crop yields.

I use difference-in-differences approach in quantifying the effect. However, I take two different approaches in defining the treatment. In the first approach, I consider just the availability of television to distinguish between counties that had access to higher-quality information and those that had not. I find that television availability leads to an increase in corn production of 0.552 to 0.732 percentage points on average. These findings are shown to be robust with different definitions of television availability, and when considering only a subset of counties that belong to so called "corn states". The effects are somewhat stronger when considering a county as treated only after the television penetrated more than 45% of households, and when restricting the analysis to the set of "corn states".

In the second approach, I account for the intensity of treatment. Specifically, I define the treatment variable as the number of years since a county experienced the entry of TV. In these specifications, I find that the effect of higher-quality weather report information on corn production is between 0.065 and 0.086 percentage points on average. These results are robust when restricting the analysis to counties from "corn states". In both cases, the results suggest that this improved quality information, through the substitution of less efficient mediums for conveying weather forecast information, has a significant effect on agricultural activity.

Several steps could be taken to further examine these results. First of all, the analysis should be conducted for other crops as well. Next, it would be interesting to conduct the analysis for years in which weather information played a particularly important role - years with adverse weather conditions, like floods or droughts. In such years, the importance of high-quality weather reports is high, and, hence, the new way of presenting weather reports should have an even bigger effect.

Additionally, including other important determinants for agricultural activity, like technological progress or subsidies, in the analysis would be a potential extension.

# Chapter 2: Bibliography


[1] Adams, M. R., Bryant, J. K., McCarl, A. B., Legler, M. D., O'Brien, J., Solow, A., Weiher, R. (1995): *Value of Improved Long-Range Weather Information*. Contemporary Economic Policy, Vol XIII: 10 – 19.

[2] Barnouw, E. (1990): *Tube of Plenty: The Evolution of American Television*. New York: Oxford University Press.

[3] Das, H. P., Doblas-Reyes, F. J., Garcia, A., Hansen, J., Mariani, L., Nain, A., Ramesh, K., Rathore, L. S., Venkataraman, R. (2012): *Weather and Climate Forecasts for Agriculture*. Guide to Agricultural Meteorological Practices (GAMP), Chapter 5.

[4] Frisvold, G. B., Murugesan, A. (2013): *Use of Weather Information for Agricultural Decision Making*. Weather, Climate, and Society, 5(1): 55 – 69.

[5] Gentzkow, M. (2006): *Television and Voter Turnout*. The Quarterly Journal of Economics, 121(3): 931 – 972.

[6] Gentzkow, M., Shapiro, J. M. (2008): *Preschool Television Viewing and Adolescent Test Scores: Historical Evidence from the Coleman Study*. The Quarterly Journal of Economics, 123(1): 279 – 323.

[7] Laskin, D. (1996): *Television: A Change in the Weather*. The New York Times.

[8] Lave, L. B. (1963): *The Value of Better Weather Information to the Raisin Industry*. Econometrica, 31(1-2): 151 – 164.

[9] Oklahoma Department of Agriculture, Food and Forestry (ODAFF): *Oklahoma Agriculture Statistics 2015. Pocket Facts.* ODAFF,USDA-NASS, OSU, Oklahoma City (2015).

[10] Rosenzweig, M., Udry, C. R. (2013): *Forecasting Profitability*. NBER working paper, No. 19334.

[11] Television Bureau of Advertising (2003): *TV basics 2003: A Report on the Growth and Scope of Television*.

[12] Ziolkowska, J. R. (2018): *Economic Value of Environmental and Weather Information for Agricultural Decisions - A Case Study for Oklahoma Mesonet*. Agriculture, Ecosystems and Environment, 265: 503 – 512.

[13] Ziolkowska, J. R., Zubillaga, J. (2018): *Importance of Weather Monitoring for Agricultural Decision-Making - An Explanatory Behavioral Study for Oklahoma Mesonet*. Journal of the Science of Food and Agriculture, 98: 4945 – 4954.

# Appendix A: Appendix for Chapter 1 - Interventions in Credit Markets and Effects on Economic Activity: Evidence from Brazil

## A.1 Facts from the Data

### A.1.1 New branches and bank entry

In the period January 2011 - March 2014, three banks were active in opening new branches. Although the majority of new branches were opened in municipalities that already had some bank access, there were also some municipalities that experienced bank entry only after January 2011. Most notably, 59 municipalities experienced entry in December 2011, and also quickly after the government introduced the low interest rate policy, 47 municipalities in March 2012 and 30 municipalities in May 2012. Bank entry into new municipalities was driven by the entry of the public banks.

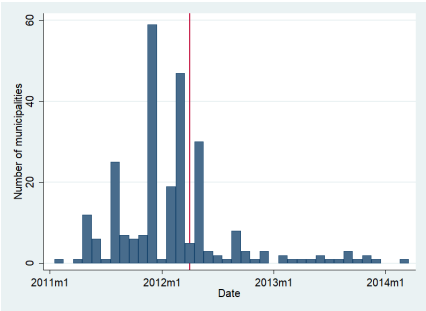



Figure A.1: Municipalities with bank entry only after January 2011

In addition to some entry into new markets, a lot of branches were open in municipalities that already had bank access. All branch openings of banks that were actively opening branches in the period are presented in Figure A.2.

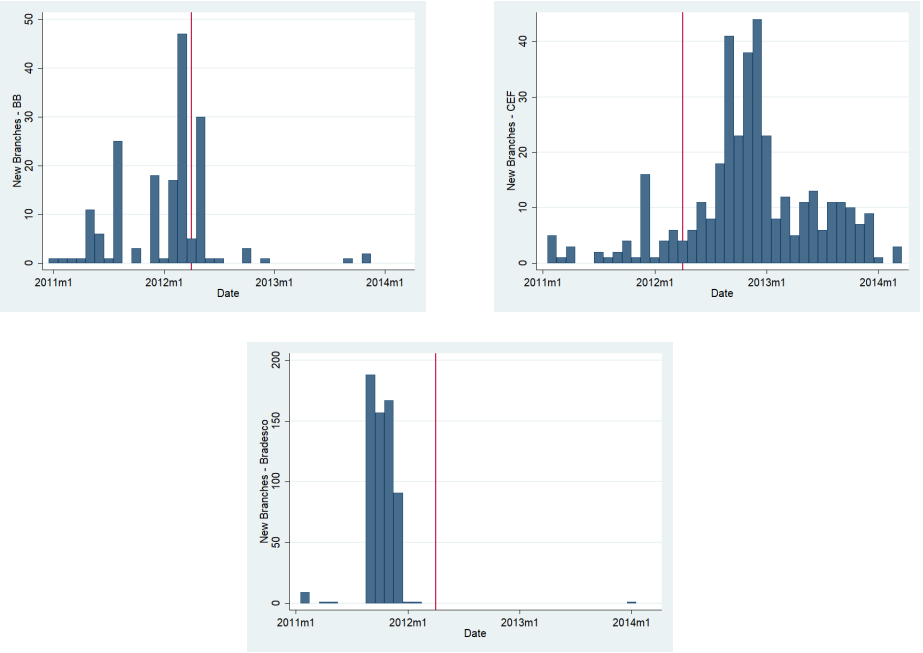



Figure A.2: Newly opened branches by bank in the period 2011-2013

From the top-left panel, it can be observed that *Banco do Brasil* opened almost 50 new branches in March 2012, the month when the government introduced low interest rate policy, and an additional 30 branches in May 2012. However, it mostly concentrated on markets in which it already operated (1,891 of them), and entered only 44 new markets. Given that it opened around 180 branches in the period 2011 - 2013, this means that 25% of new branches represented entering new markets for *Banco do Brasil*.

On the other hand, *Caixa Economica Federal* systematically entered many new markets following the introduction of the policy and opened more than 300 new branches, which may not be surprising as its main focus is making mortgages available (and this was one of the goals of the government policy). To be more precise, once the policy was introduced, *Caixa* opened 329 new branches. Out of those, 315 branches were opened in municipalities where *Caixa* was not present before the policy was introduced. This amounts to almost doubling its presence in small markets since it operated in 397 municipalities before March 2012.

Finally, *Banco Bradesco* had a short period of actively opening many new branches (more than

600) in the Fall of 2011. However, all of its new branches were open in municipalities where it already operated (1,070 municipalities), and it did not enter new markets in the period 2011 - 2013.

While *Itau* and *Banco Santander* did not create a large number of new branches in this period, there are a couple of things worth mentioning. *Itau* operated in 587 municipalities before March 2012, and out of its 15 new branch openings in the period 2011 - 2013 only 4 represented entering into new markets. On the other hand, *Banco Santander* opened 11 new branches in the period in question, and out of those 3 openings meant entering the new market. This gave a total of 330 municipalities in which *Banco Santander* operated in the period 2011 - 2013.

### A.1.2 Structure of the asset side of balance sheets of five largest banks

*Banco do Brasil* specializes in issuing personal credit and agricultural loans. The asset side of the CEF's balance sheet is heavily occupied by personal credit and mortgages.

On the other hand, all three private banks specialize heavily in personal loans, with *Bradesco* also issuing substantial amounts of agricultural loans, *Itau* offering investment loans, and *Santander* adding both of these types of loans.


Figure A.3: Trends in proportion of each loan category in bank's total issued credit

Notes: Top-left panel is for *Banco do Brasil*; top-right panel shows *Caixa Economica Federal*; middle-left panel is for *Banco Bradesco*; middle-right panel shows *Itau*; bottom panel *Santander*.

### A.1.3 Loan origination by bank type

| | Pre-policy | | | Post-policy | | |
|---|---|---|---|---|---|---|
| Loan category | Mean | StDev | N | Mean | StDev | N |
| *Public Banks* | | | | | | |
| Personal Credit | 106,203.8 | 476,972.7 | 34,893 | 217,519.9 | 543,009.9 | 64,167 |
| Investments | 24,318.9 | 215,438.6 | 34,893 | 84,537.9 | 270,617.5 | 64,167 |
| Agricultural Loans | 146,818.7 | 742,594.3 | 34,893 | 254,174.1 | 1,038,598.0 | 64,167 |
| Mortgages | 102,190.5 | 360,801.5 | 34,893 | 160.357.5 | 464,991.0 | 64,167 |
| Other Credits | 43,507.6 | 1,251,306.0 | 34,893 | 14,580.4 | 2,083,693.0 | 64,167 |
| *Private Banks* | | | | | | |
| Personal Credit | 75,756.6 | 436,300.0 | 29,176 | 5,547.2 | 383,308.5 | 55,853 |
| Investments | 5,111.4 | 192,769.5 | 29,176 | 5,748.8 | 244,940.4 | 55,853 |
| Agricultural Loans | 5,105.7 | 599,911.2 | 29,176 | 14,203.1 | 495,970.1 | 55,853 |
| Mortgages | 0.0 | 0.0 | 29,176 | 0.0 | 0.0 | 55,853 |
| Other Credits | 875.9 | 79,014.83 | 29,176 | 409.2 | 90,884.5 | 55,853 |

Table A.1: Loan origination of public and private banks before and after the low interest rate policy was introduced

### A.1.4 Trends in deposit creation

I start by briefly examining trends in deposits and deposit creation over the period January 2011 - March 2014. Table A.2 shows new deposits across public and private banks. Over the period 2011-2013, we can see that private banks were increasing checking deposits faster, while public banks were increasing savings deposits by more than their private competitors. However, creation of new term deposits slowed down after the policy.

| | Public Banks | | | Private Banks | | |
|---|---|---|---|---|---|---|
| Deposit type | Mean | StDev | N | Mean | StDev | N |
| Checking | 5,516.8 | 1,257,064.0 | 99,060 | 9,863.2 | 705,180.6 | 85,029 |
| Savings | 193,346.9 | 596,341.3 | 99,060 | 101,245.4 | 410,769.7 | 85,029 |
| Term deposits | 77,649.5 | 3,932,145.0 | 99,060 | 28,258.0 | 1,246,981 | 85,029 |

Table A.2: New deposits over the period Jan 2011 - Mar 2014 for public and private banks

Breaking this down to pre- and post-policy to observe a pattern in deposit creation, we can see from Table A.3 that both public and private banks went from losing checking deposits to creating them after March 2012, with a more pronounced change in the case of public banks. On the other hand, in both types of banks a higher creation of savings deposits was observed after the low interest rate policy was introduced, with an increase of roughly 50% in savings deposit creation for public and a 100% for private banks. As for term deposits, we can still observe a slowing down of their creation after the policy was introduced, and in the case of private banks we can even observe a decrease in term deposits.

| | Pre-policy | | | Post-policy | | |
|---|---|---|---|---|---|---|
| Deposit type | Mean | StDev | N | Mean | StDev | N |
| *Public Banks* | | | | | | |
| Checking | -31,213.8 | 1,061,519.0 | 34,893 | 25,490.3 | 1,351,164.0 | 64,167 |
| Savings | 148,818.1 | 652,051.0 | 34,893 | 217,560.9 | 562,268.1 | 64,167 |
| Term deposits | 154,124.8 | 1,532,918.0 | 34,893 | 36,063.4 | 4,752,584.0 | 64,167 |
| *Private Banks* | | | | | | |
| Checking | -5,260.1 | 727,368.5 | 29,176 | 17,763.2 | 693,183.5 | 55,853 |
| Savings | 67,135.2 | 349,304.4 | 29,176 | 119,063.5 | 438,421.4 | 55,853 |
| Term deposits | 105,184.8 | 1,244,905.0 | 29,176 | -11,926.41 | 1,246,189.0 | 55,853 |

Table A.3: Deposit creation of public and private banks before and after the low interest rate policy was introduced

However, this is not entirely informative as there is high volatility of deposit creation over the period, reflected in very high standard deviation.

In Figure A.4 I contrast how loans and deposits evolved over the period I am analyzing. From the left panel, we can see that both loans and deposits were increasing on average after the government intervention in March 2012, however, the growth rate of deposits was visibly smaller. From the left panel we can see month-to-month changes in loans and deposits.

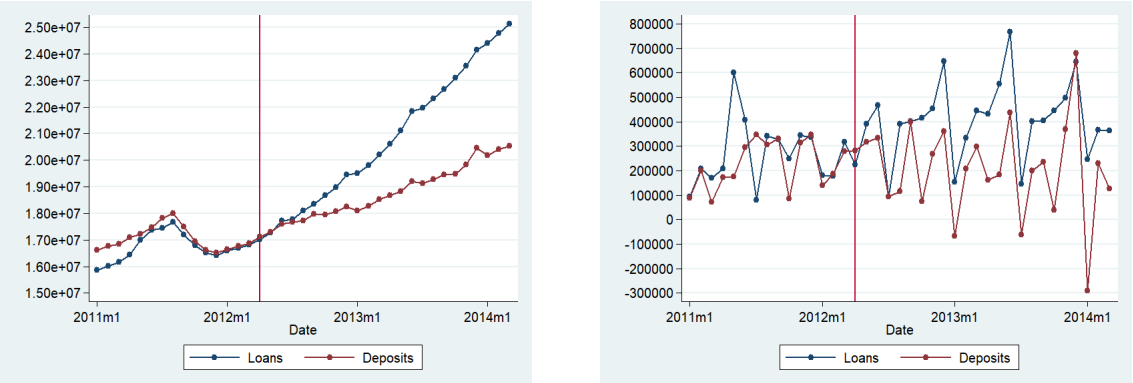



Figure A.4: Trends in loans and deposits

Notes: Left panel shows total values, while the left panel presents month-to-month changes in loans and deposits.

## A.2 Additional Analysis of Effects on Economic Activity

### A.2.1 Real Impacts by Municipality Income

In this section I re-estimate the effects of the policy on real outcomes, distinguishing municipalities by their level of income. I estimate the regression equation:

$$\log y_{m,t} = \sum_{i=1}^{5} \beta_i \log TL_{m,t} \times I_{i,m} + \gamma X_{m,t-1} + \mu_m + \mu_t + u_{m,t} \tag{A.1}$$

which is a slightly modified version of equation 1.6. The difference is that here I incorporate an indicator variable $I_{i,m}$ which is equal to 1 if municipality $m$ belongs to the $i$-th quintile of the income distribution, as measured by the municipality level GDP from 2011.

Results are presented in Table A.4. Overall, the effect of the policy on real outcomes remains negligible. Another insight from the results is that the effect was very similar across municipalities with different levels of income. To put it differently, municipalities of different wealth levels did not experience statistically significant responses of real outcomes to the policy, and for all of them the response was economically negligible. The only exception from this pattern was the group of wealthiest municipalities. The effects of the policy were negative in these municipalities; still, they remain economically negligible.

| | GDP | | | | Employment | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| log(TL) | 0.011* | 0.009 | 0.017 | 0.020 | 0.082* | 0.082* | -0.003 | -0.001 |
| | (0.006) | (0.007) | (0.013) | (0.013) | (0.046) | (0.046) | (0.026) | (0.027) |
| log(TL)×$I_2$ | -0.007 | -0.007 | 0.029 | 0.025 | -0.071 | -0.071 | 0.015 | 0.013 |
| | (0.010) | (0.010) | (0.019) | (0.019) | (0.044) | (0.044) | (0.030) | (0.030) |
| log(TL)×$I_3$ | -0.003 | -0.000 | -0.030 | -0.033* | -0.28 | -0.027 | 0.004 | 0.003 |
| | (0.009) | (0.010) | (0.018) | (0.018) | (0.053) | (0.053) | (0.029) | (0.029) |
| log(TL)×$I_4$ | -0.007 | -0.006 | -0.028 | -0.031 | -0.066 | -0.066 | 0.012 | 0.013 |
| | (0.008) | (0.009) | (0.022) | (0.022) | (0.044) | (0.044) | (0.028) | (0.029) |
| log(TL)×$I_5$ | -0.070*** | -0.078*** | -0.076*** | -0.090*** | -0.083** | -0.080* | -0.026 | -0.022 |
| | (0.020) | (0.020) | (0.022) | (0.022) | (0.042) | (0.042) | (0.028) | (0.029) |
| log(TT) | - | Y | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 6,682 | 6,553 | 6,524 | 6,403 | 6,667 | 6,554 | 6,509 | 6,404 |

Table A.4: Effect of increase in total lending on GDP and employment

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

### A.2.2 Municipalities with no bank access prior to January 2011

In Figure A.5, I present the relationship between GDP/employment and increase in total lending for municipalities that had no bank presence before January 2011, but experienced bank entry only after this date. This is the analysis similar to the one I conducted in the main body of the paper, where I first take out all the effects of control variables and fixed effects from GDP, employment, and total lending, and then plot the former two against total lending to understand if different levels of increase in lending affected economic outcomes differently. While there is seemingly no relationship between GDP and total lending, a positive relationship is observed between employment and increase in total lending in municipalities that experienced bank entry after January 2011.

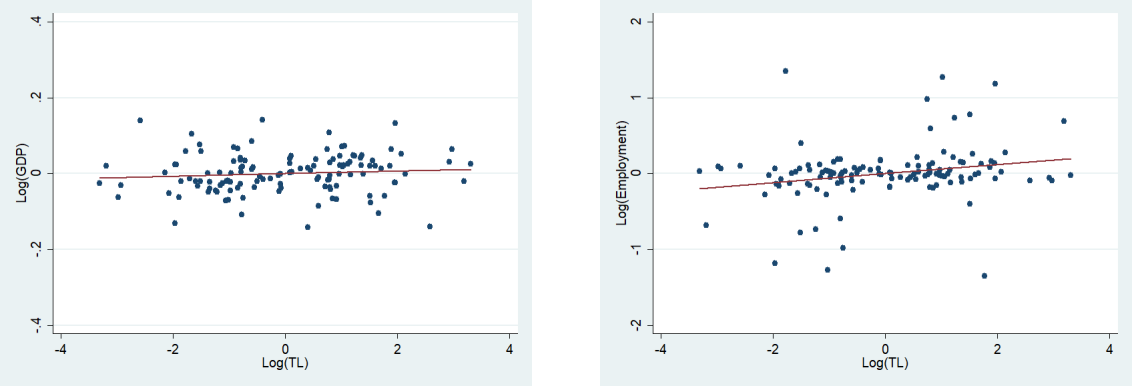



Figure A.5: GDP and employment plotted against total lending

### A.2.3 Effects on tradable and non-tradable sector

Not all sectors of a municipality's economy are reliant solely on local demand. For example, industry products can be tradable and the level of production is not just driven by local demand, in contrast to services. It is very unlikely that someone will buy a kitchen appliance produced within the very same municipality she lives in, while on the other hand it is not very likely that the same person would travel to a different municipality to have a haircut. Therefore, in this part I examine if the effect of increase in total lending was different in tradables sector.

For this purpose, I estimate a regression equation that is similar to equation (1.6). As a dependent variable I use different proxies of activity in the tradables sector - industry value added at the municipality level, as industry products can be sold at other municipalities and hence can proxy for production of tradable goods, as well as employment and average wage in tradables sector. In some specifications I use total lending as an explanatory variable, while in others I use total investment lending (as this form of lending should be used for investments).

Results are preented in Table A.5. What stands out as an immediate conclusion is that the effect of increase in total lending has no effect on economic activity in tradables sector. Hence, there is no support for the story that the effect of increase in lending could be different in sectors of the economy that are not reliant solely on local demand but could also sell outside of the local region.

| | Industry VA | | | | Employment (tradables) | | | | Wages (tradables) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| log(TL) | -0.01 | -0.01 | | | -0.03 | -0.04 | | | 0.02 | 0.01 | | |
| | (0.02) | (0.02) | | | (0.04) | (0.04) | | | (0.02) | (0.02) | | |
| log(TLinv) | | | -0.00 | 0.00 | | | -0.02 | -0.01 | | | -0.00 | 0.00 |
| | | | (0.01) | (0.01) | | | (0.02) | (0.02) | | | (0.01) | (0.01) |
| log(TT) | - | Y | - | Y | - | Y | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 6,098 | 5,974 | 6,098 | 5,974 | 5,774 | 5,669 | 5,774 | 5,669 | 5,693 | 5,622 | 5,693 | 5,622 |

Table A.5: Effect of increase in total lending on tradable sector

Notes: $log(TL)$ represents the logarithm of total lending, while $log(TLinv)$ is the logarithm of total amount of investment loans. Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

For industry value added, I have also run the regressions constraining the sample to only municipalities where *Banco do Brasil*, *Bradesco* and *Santander* operate, as those banks specialize in providing investment loans. However, the results are essentially the same as that in Table A.5. I obtain the same result in the case of employment and wages in tradables sector when the analysis is constrained to municipalities where those three banks operates.

I have also run regressions with services value added, employment in non-tradables sector and wages in non-tradables sector as dependent variables which led to the same results, reconfirming that the increase in total lending on economic activity at the municipality level.

| | Services VA | | | | Employment (non-tradables) | | | | Wages (non-tradables) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| log(TL) | -0.01 | -0.01 | | | -0.00 | -0.00 | | | -0.00 | -0.00 | | |
| | (0.01) | (0.01) | | | (0.01) | (0.01) | | | (0.01) | (0.01) | | |
| log(TLinv) | | | -0.00 | 0.00 | | | -0.02** | -0.02** | | | -0.01 | -0.01 |
| | | | (0.01) | (0.01) | | | (0.01) | (0.01) | | | (0.01) | (0.01) |
| log(TT) | - | Y | - | Y | - | Y | - | Y | - | Y | - | Y |
| log(wage) | - | Y | - | Y | - | Y | - | Y | - | Y | - | Y |
| log(agrpr) | - | Y | - | Y | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 6,111 | 5,987 | 6,111 | 5,987 | 6,095 | 5,987 | 6,095 | 5,987 | 6,095 | 5,987 | 6,095 | 5,987 |

Table A.6: Effect of increase in total lending on non-tradable sector

Notes: $log(TL)$ represents the logarithm of total lending, while $log(TLinv)$ is the logarithm of total amount of investment loans. Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

### A.2.4 Effects on agricultural activity

As presented above, the increase in agricultural loans seems to have the negative effect on the overall GDP. Given the availability of the data, I want to examine what is the particular effect of agricultural loans on activity in agricultural sector, namely, agricultural value added as well as the average corn yield. For this purpose I estimate the following regression:

$$\log y_{m,t} = \beta \times \log TAL_{m,t-1} + \gamma X_{m,t-1} + \mu_m + \mu_t + u_{m,t}$$

which is very similar to regression specification from equation 1.6, with the difference that I am using $\log TAL_{m,t}$, total agricultural lending, as the variable of interest. Results are presented in Table A.7.

The effect is significant at the 5% level for both outcomes. A 1% increase in agricultural lending leads to a 0.02% increase in agricultural value added, on average. When it comes to corn yield, a 1% increase in total agricultural lending leads to a 0.065% increase in average corn yield. These results suggest that the productivity in agricultural sector and the product of agricultural sector indeed benefit from increase in availability of agricultural loans.

| | Agriculture VA | | | | Corn yield | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) | (5) |
| log(TAL) | 0.022** | 0.021** | 0.022** | 0.020** | 0.065** | 0.058** | 0.064** | 0.069** | 0.061** |
| | (0.09) | (0.009) | (0.009) | (0.009) | (0.026) | (0.025) | (0.026) | (0.026) | (0.025) |
| log(TT) | - | Y | - | Y | - | Y | - | - | Y |
| log(wage) | - | - | Y | Y | - | - | Y | - | Y |
| log(agrpr) | - | - | - | - | - | - | - | Y | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Mun FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| N | 5,334 | 5,310 | 5,280 | 5,256 | 5,157 | 5,133 | 5,103 | 5,155 | 5,077 |

Table A.7: Effect of increase in total agriculture lending on agriculture product and corn yield

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

### A.2.5 Effects on informal economy

One possibility that remains is that the increase in credit supply was "spent" in informal economy. In this part, I will try to assess to what if and to what extent this might be the case. On one hand, for a firm that operates within the informal economy it might be very difficult to obtain access to credit. For this reason, I would expect that the effect of increase in lending is very limited in the informal sector. However, this is only the "extensive margin". On the other hand, the "intensive margin" needs to be considered - the possibility of a formal firm employing workers "out of records". Hence, it is possible that increase in lending leads to higher employment when informal economy is considered.

I use the National Household survey (PNAD), representative at the national level, to construct a measure of employment in the informal economy. PNAD contains information on the number of people who were employed during the survey week within a state (unfortunately, the lowest level of aggregation is the state level). I use this data as a proxy for the total number of employees within a state. On the other hand, using RAIS data on formal employment, I calculate the number of formal employees within a state. I use the difference as an estimate of informally employed workers.

Results of regression analysis are presented in Table A.8. Across all specifications, we can see that a 1% increase in total lending leads to a 0.04-0.08% increase in informal employment, on average. More importantly, the effect is negligible.

Of course, these results need to be taken with caution. Given that I am constraining the analysis to the period 2011-2013, to understand the short-term effects of the policy without allowing much time and space for other external shocks, and the fact that PNAD provides data at the state level, I am left with a very small sample based on which I estimate the effects increased lending had on informal employment. A potentially better estimate would be obtained if informal employment could be estimated at the lower level of aggregation, say at the micro-region level.

| | Employment | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| log(TL) | 0.0861 | 0.0635 | 0.0488 | 0.0825 | 0.0401 |
| | (0.1136) | (0.1114) | (0.1371) | (0.1034) | (0.1238) |
| log(TT) | - | Y | - | - | Y |
| log(wage) | - | - | Y | - | Y |
| log(agrpr) | - | - | - | Y | Y |
| N | 75 | 75 | 72 | 75 | 72 |

Table A.8: Effect of increase in total lending on informal employment (at state level)

Notes: Standard errors are clustered at the state level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

## A.3 Alternative Instruments

In this section I use alternative instruments in applying the Imbens and Newey (2009) procedure to deal with the potential endogeneity problem of total lending. Specifically, I use three different instrument, where each one of them represents a measure of public bank presence in a municipality.[1]

As the first instrument, I use the number of public branches in municipality $m$. As the second instrument, I use the market share of public banks within the municipality calculated using the total number of operational branches of both public and private banks in that municipality. Finally, the third instrument is constructed as the market share of public credit in the total amount of credit issued within the municipality.

Results are presented in Tables A.9, A.10, and A.11. Each table presents results using one of the alternative measures of public bank presence in the municipality. Overall, the estimated effect of the policy on GDP and employment remains negligible. It is important to note that neither the number of public branches nor the market share of public banks measured by the number of branches are not relevant instruments. This is shown in the 1st stage results of both Table A.9 and Table A.10. The third instrument, market share of public credit in total municipality credit, seems to be (weakly) relevant, as the instrument is significant at 10%. However, in this particular case, the estimated effect of the policy is an order of magnitude smaller, suggesting that the policy did not affect GDP and employment. Finally, worth noting is that the coefficients on the constructed control variable in the second stage regression are jointly insignificant, confirming the original results when $Post_t$ was used as an instrument that there is no selection on unobservables.

[1] I apply the same procedure as decsribed in section 4 (*Empirical Strategy*), where I substitute the $Post_t$ instrument with the alternative instruments measuring presence of public banks.

| | *Instrument:* Number of public bank branches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | GDP | | | | Employment | | | |
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Marginal effect | -0.0041* | -0.0041* | -0.0061* | -0.0061* | -0.0003 | -0.0003 | 0.0001 | 0.00002 |
| (p-value) | (0.096) | (0.098) | (0.078) | (0.085) | (0.337) | (0.340) | (0.139) | (0.146) |
| log(TT) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(wage) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(agrpr) | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}_{m,t}$ | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}^2_{m,t}$ | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Municipality FE | Y | Y | Y | Y | Y | Y | Y | Y |
| F-stat | 2.00 | 1.73 | 0.73 | 0.92 | 4.49 | 2.55 | 1.97 | 1.47 |
| (p-value) | (0.111) | (0.109) | (0.535) | (0.482) | (0.018) | (0.0002) | (0.116) | (0.184) |
| N | 6,553 | 6,553 | 6,403 | 6,403 | 6,554 | 6,554 | 6,404 | 6,404 |
| *1st stage* | | | | | | | | |
| F-stat | 5.73 | 5.73 | 5.74 | 5.74 | 5.73 | 5.73 | 5.74 | 5.74 |
| (p-value) | (0.126) | (0.126) | (0.125) | (0.125) | (0.126) | (0.126) | (0.125) | (0.125) |

Table A.9: Effect of increase in total lending on GDP and employment (Imbens and Newey)

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

| | *Instrument:* Market share of public bank branches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | GDP | | | | Employment | | | |
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Marginal effect | -0.0019 | -0.0019 | -0.0033** | -0.0033** | -0.0003 | -0.0002 | 0.0011 | 0.0011 |
| (p-value) | (0.135) | (0.152) | (0.030) | (0.034) | (0.352) | (0.359) | (0.154) | (0.163) |
| log(TT) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(wage) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(agrpr) | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}_{m,t}$ | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}^2_{m,t}$ | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Municipality FE | Y | Y | Y | Y | Y | Y | Y | Y |
| F-stat | 1.80 | 1.69 | 1.31 | 1.31 | 4.58 | 2.67 | 2.21 | 1.62 |
| (p-value) | (0.145) | (0.120) | (0.270) | (0.250) | (0.003) | (0.014) | (0.085) | (0.137) |
| N | 6,553 | 6,553 | 6,403 | 6,403 | 6,554 | 6,554 | 6,404 | 6,404 |
| *1st stage* | | | | | | | | |
| F-stat | 3.79 | 3.79 | 4.55 | 4.55 | 3.79 | 3.79 | 4.55 | 4.55 |
| (p-value) | (0.285) | (0.285) | (0.208) | (0.208) | (0.285) | (0.285) | (0.208) | (0.208) |

Table A.10: Effect of increase in total lending on GDP and employment (Imbens and Newey)

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

| | *Instrument:* Market share of public credit | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | GDP | | | | Employment | | | |
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Marginal effect | -0.0003 | -0.0003 | -0.0007 | -0.0008 | -0.00003 | -0.00001 | -0.0004 | -0.0003 |
| (p-value) | (0.654) | (0.705) | (0.754) | (0.735) | (0.513) | (0.499) | (0.163) | (0.178) |
| log(TT) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(wage) | Y | Y | Y | Y | Y | Y | Y | Y |
| log(agrpr) | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}_{m,t}$ | Y | Y | Y | Y | Y | Y | Y | Y |
| $\hat{\varepsilon}^2_{m,t}$ | - | Y | - | Y | - | Y | - | Y |
| Time FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Municipality FE | Y | Y | Y | Y | Y | Y | Y | Y |
| F-stat | 0.67 | 1.24 | 0.57 | 1.12 | 4.45 | 2.53 | 2.15 | 1.64 |
| (p-value) | (0.571) | (0.284) | (0.634) | (0.346) | (0.004) | (0.019) | (0.092) | (0.131) |
| N | 6,553 | 6,553 | 6,403 | 6,403 | 6,554 | 6,554 | 6,404 | 6,404 |
| *1st stage* | | | | | | | | |
| F-stat | 6.68 | 6.68 | 6.37 | 6.37 | 6.68 | 6.68 | 6.37 | 6.37 |
| (p-value) | (0.083) | (0.083) | (0.095) | (0.095) | (0.083) | (0.083) | (0.095) | (0.095) |

Table A.11: Effect of increase in total lending on GDP and employment (Imbens and Newey)

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

## A.4 Effects of bank entry

In the results I obtained it seems that, if there are real effects of an increase in lending, they are coming from municipalities that experienced bank entry only after January 2011 (and not having bank access prior to that date). This may suggest that the availability of financial institution is more important for economic activity than the lending intensity.

To explore this possibility, I split the sample into the treatment group (municipalities that had no access prior to January 2011) and the control group (municipalities with bank presence before January 2011). To assess the difference that bank presence in a municipality makes I use the following regression specification:

$$\log y_{m,t} = \beta_1 \times Treated_m \times Post_t + \gamma X_{m,t-1} + \mu_m + \mu_t + u_{m,t} \tag{A.2}$$

where $Treated_m$ is an indicator equal to 1 if municipality $m$ experienced bank entry after January 2011 without having bank presence before the date, and $Post_t$ is an indicator variable equal to 1 for all periods after March 2012.

| | GDP | | Employment | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $Treated_m \times Post_t$ | 0.0192 | 0.0692 | 0.0250 | 0.0099 |
| | (0.0147) | (0.0438) | (0.0282) | (0.0739) |
| $Treated_m \times Post_t \times Public_m$ | - | -0.0678 | - | 0.0205 |
| | - | (0.0452) | - | (0.0787) |
| N | 9,619 | 9,619 | 9,620 | 9,620 |

Table A.12: Effect of bank entry on GDP and employment

Notes: Standard errors are clustered at the municipality level. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

The results are statistically insignificant. However, looking at numbers we can see that obtaining bank access leads to a 1.92% higher GDP growth. The effect is substantially more pronounced

for municipalities that experienced entry of a private bank. These results suggest that bank access might be important for the development of a municipality, which is in line with results from Fonseca and Matray (2022). On the other hand, results for employment are very noisy, but the estimates suggest that the entry of a public bank is important for growth of employment.

These results, however, should be taken with caution, especially for two reasons. First, the number of municipalities that experienced bank entry in the period 2011-2013 is very small (190 municipalities out of 2,400 that are in my analysis). Second, it is very unclear whether banks' entry decisions are independent from municipality's growth trajectory, i.e., the decision to enter a new market is likely related to economic conditions in that market. It is possible that, as a public bank, one of the objectives of *Banco do Brasil* is client reach, so it may enter markets and offer credit in municipalities that are not quickly developing. This concern is slightly mitigated by the fact that BB is publicly traded and therefore subject to constraints of the stock market. On the other hand, private banks' ultimate goal is profitability so it is expected that they would enter only those markets in which their profitability would be the highest, and these could be municipalities experiencing speedy development, which would drive the results and bias them upwards as these municipalities would already be on the high growth trajectory.

# Appendix B: Appendix for Chapter 2 - Television Introduction and Agricultural Production

## B.1 Television Penetration

Data on the percent of households owning a TV set can be used to understand better the process of diffusion of television geographically and over time upon its introduction. This data contains information on the number of households owning a TV set and the total number of households within each county over the period 1950-1960. For the ending years of the period (1950 and 1960), census was used to compile the data, while county-level television penetration for the years in between data was compiled using *Television Magazine* in respective years.

Looking at the heat maps in Figure B.1, we can observe that the diffusion of television was quite rapid over this decade. From panel A, we can see that county-level television penetration was concentrated only in certain areas of the US, in particular in counties of the following states NY, NJ, PA, MD, MI, OH, IN, IL, WI, IA, CA.

Until 1955, the diffusion process was already at full speed, with many counties across the US having more than 50% of households owning a TV set.[1] Finally, looking at panel C, we can see that, by 1960, television was well diffused across the US. Still, there were substantial differences in television penetration across different regions, particularly in some regions of the mid-west. We can see that states MT, WY, CO, NM, AZ and UT are still having lower levels of county-level television penetration.

[1]Note that the data for 1955 was not complied from the census, hence, data is missing for a certain percentage of counties. Moreover, inspection of raw data tells that conclusions about households owning a TV set are based on sampling procedures.

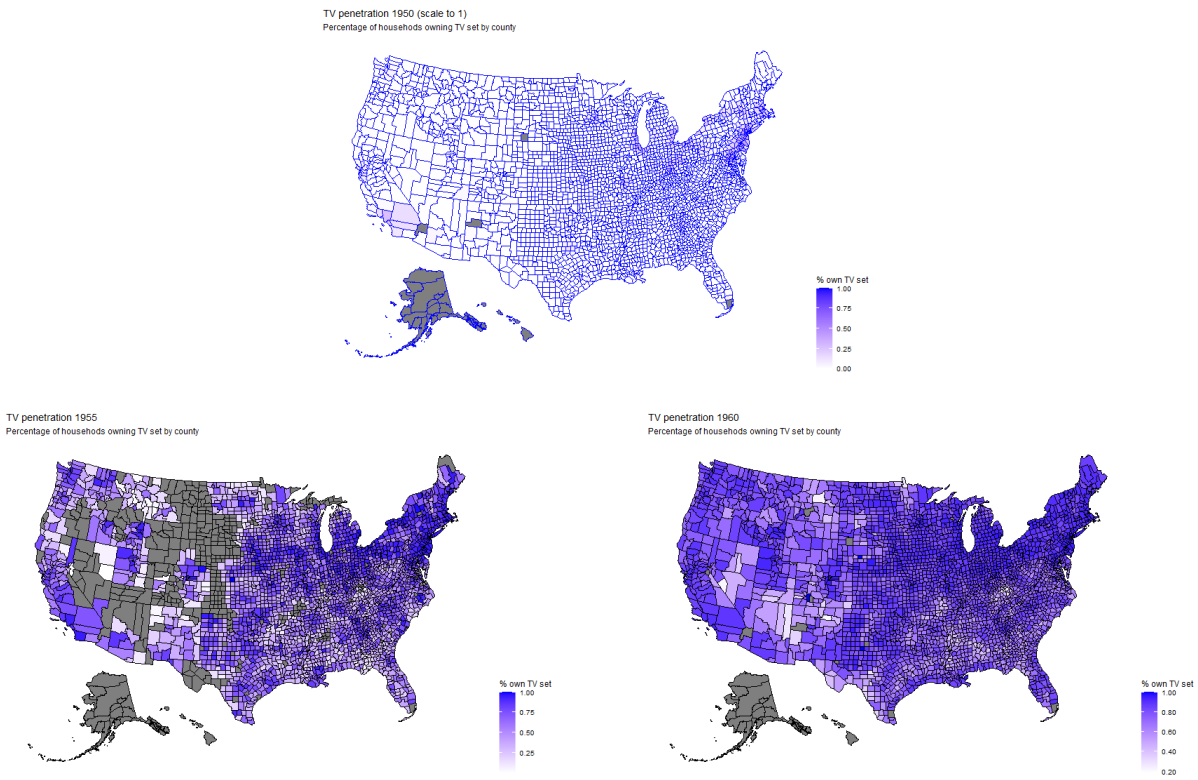



Figure B.1: County-level Television Penetration

In subsection 6.1, alternative definitions of *Treatment* variable were used. In particular, *Treatment* was defined to take the value of 1 only after a certain threshold of households within the county already owned a TV set. Instead of defining a binary variable depending on the threshold, one might simply use the fraction of households owning a TV set as an explanatory variable itself. However, due to data limitations this might be problematic. Data on county-level television penetration is available only for the period 1950-1960. Within this period only for 1954 and 1959 data on agricultural activity is available. Moreover, data on diffusion of television for these two years is actually compiled using some sampling techniques.

## B.2 Demeaned trends in corn production

Panels of Figure B.2 show demeaned trends in corn production. I used the average corn production of counties within a state that were not yet treated as a demeanor. So for each observation I found the difference between the average corn production in the county and the average corn production of non-treated counties within the state where that county is located. Essentially, I use the following formula to calculate the demeaned corn production:

$$y_{ist} - \bar{y}_{jst}\Big|_{j \notin Treatment}$$

where $y_{ist}$ is the average corn production of county $i$ in state $s$ in year $t$, and $\bar{y}_{jst}$ represents the state-wide average of corn production of counties that were not yet treated.

Looking at panel A that contains counties that experienced the entry of television first, it is possible to conclude that after television became available, those counties had higher average production of corn relative to the counties within that same state that have not yet experienced TV entry. Before television became available, the treated counties were comparable to those that were not treated, except for the outlier in 1939.

On the other hand, Panel B shows the difference between county and state average corn production for counties experiencing TV entry between 1946 and 1948. The difference is more pronounced after the television signal reached these counties, however, difference is observed also before the entry of TV which requires further investigation.

I do not provide the figure for the group of counties that experienced the entry of television last, as there are no non-treated counties which I can use to calculate the state average corn production.

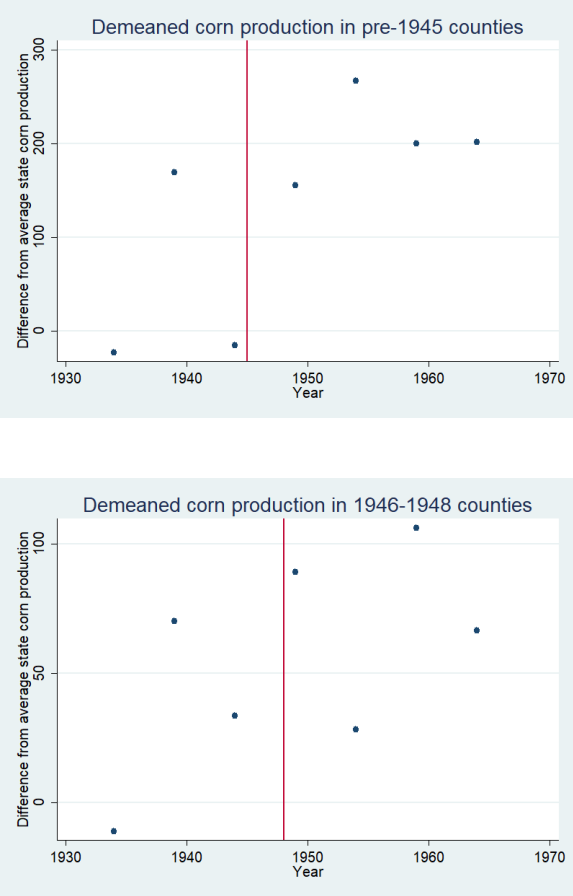



Figure B.2: Trends in Corn Production Across Different Groups of Counties

## B.3 Revisiting Television Availability

Results in Table B.1 are obtained by looking at the time horizon the television was available in a particular county, and estimating the regressions:

$$\log Y_{it} = \alpha_i + \beta_1 \times Treatment[0,5)_{it} + \beta_2 \times Treatment[5,10)_{it} + \beta_3 \times Treatment[10,15)_{it} + \beta_4 \times Treatment[15,20)_{it} + \gamma X_{it} + \varepsilon_{it},$$

Variable *Treatment[0, 5)* is a binary variable taking the value of one if television became available in the county in question within the last 5 years, and zero otherwise. Similarly, *Treatment[5, 10)* is a binary variable that takes the value 1 if it has been more than 5 but less than 10 years since television became available in the county. In this way, I allow for a general relationship between time since television introduction and agricultural activity (without imposing that this relationship is, say, linear).

Results show that there is a positive, significant and growing relationship between television availability and corn production. This relationship is preserved even when controlled for the average farm size (in specification (2)), for World War II (in specification (3)), and for both of control variables (in specification (4)).

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Treatment [0, 5) | 0.362*** | 0.277*** | 0.456*** | 0.350*** |
| | (0.0135) | (0.0102) | (0.0143) | (0.0117) |
| Treatment [5, 10) | 0.768*** | 0.590*** | 0.863*** | 0.665*** |
| | (0.0157) | (0.0129) | (0.0163) | (0.0147) |
| Treatment [10, 15) | 1.040*** | 0.796*** | 1.136*** | 0.873*** |
| | (0.0172) | (0.0142) | (0.0180) | (0.0165) |
| Treatment [15, 20) | 1.133*** | 0.831*** | 1.239*** | 0.917*** |
| | (0.0289) | (0.0208) | (0.0294) | (0.0230) |
| log(average farm size) | | 0.775*** | | 0.761*** |
| | | (0.0384) | | (0.0374) |
| 1944 dummy | | | 0.356*** | 0.271*** |
| | | | (0.0131) | (0.0153) |
| County FE | Yes | Yes | Yes | Yes |
| *R*-squared | 0.73 | 0.83 | 0.74 | 0.84 |
| *N* | 19,912 | 19,899 | 19,912 | 19,899 |

Table B.1: Regressions of Average Corn Production on Years of Television Availability

Notes: Standard errors are clustered by county. Variable *Treatment[0, 5)* equals 1 if not more than 5 years has passed since the introduction of television in the county. The dependent variable is the natural logarithm of the average corn production. All specification include county fixed-effects. Specifications (2) and (4) include the *average farm size* variable, that is supposed to control for the fact that larger farms have the potential of growing more corn. Specifications (3) and (4) take into account World War II by including a dummy variable for 1944.

In order to obtain better insight into the nature of this relationship, estimated coefficients of the treatment variable should be plotted. For example, Figure B.3 shows that the coefficients from specification (2) are forming a logarithmic relationship.

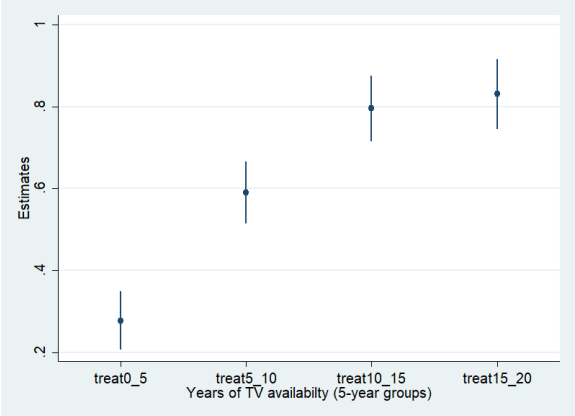



Figure B.3: Coefficients from specification (2)

I conduct a similar analysis to this, allowing for a non-linear effect of the introduction of television, but looking at the exact number of years since the introduction of television. Specifically, I estimate the following regression:

$$\log Y_{it} = \alpha_i + \sum_{t=-6}^{10} \beta_t \times Years_{it} + \gamma X_{it} + \varepsilon_{it},$$

where $Years_{it}$ is an indicator variable equal to 1 if exactly $t$ years passed since the introduction of television in county $i$.[2] Estimates from the regression are plotted in Figure B.4. Results confirm a non-linear (logarithmic) effect. This provides further evidence that the effect on agricultural activity grows stronger as television diffuses across the county.

[2]Negative $t$ denotes the number of years before the introduction of television.

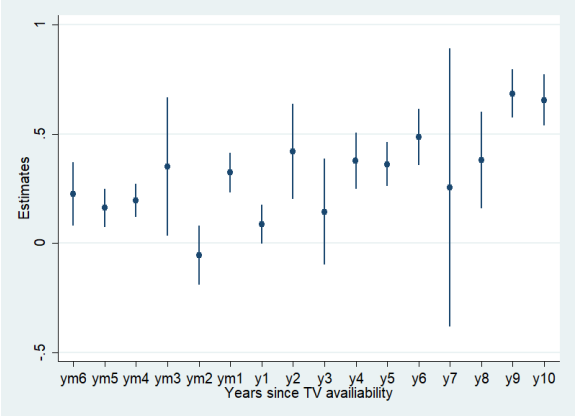



Figure B.4: Estimation of non-linear effects of television introduction on agricultural activity