



PEDL Research Papers

This research was partly or entirely supported by funding from the research initiative Private Enterprise Development in Low-Income Countries (PEDL), a Department for International Development funded programme run by the Centre for Economic Policy Research (CEPR).

This is a PEDL Research Paper which emanates from a PEDL funded project. Any views expressed here are those of the author(s) and not those of the programme nor of the affiliated organizations. Although research disseminated by PEDL may include views on policy, the programme itself takes no institutional policy positions

Capital Allocation Across Regions, Sectors and Firms

Evidence from a Commodity Boom in Brazil*

Paula Bustos Gabriel Garber Jacopo Ponticelli[†]

February 2017

Abstract

We study the allocation of capital across regions, sectors and firms. In particular, we assess to what extent growth in agricultural productivity can lead to an increase in the supply of credit in industry and services. For this purpose, we identify an exogenous increase in agricultural profits due to the adoption of genetically engineered soy in Brazil. We find that regions with larger increases in agricultural productivity experienced larger increases in local bank deposits. However, larger deposits did not translate into larger bank lending at local level. Instead, capital was reallocated towards other regions through bank branch networks. This increase in credit supply affected firms' credit access through the extensive and intensive margin. First, regions with more bank branches receiving funds from soy areas experienced an increase in credit market participation of small and medium sized firms. In addition, banks experiencing faster deposit growth in soy areas increased their lending to firms with whom they had preexisting relationships. In turn, these firms grew faster in terms of employment and wage bill. Our estimates imply that the elasticity of firm growth to credit is largest for firms in the manufacturing and service sectors, and smallest in agriculture. These findings indicate that agricultural productivity growth can lead to structural transformation through a financial channel.

Keywords: Bank Networks, Banking, Structural Transformation, Financial Constraints.

JEL Classification: G21, Q16, E51

*We received valuable comments from Francisco Buera, Nicola Gennaioli, Sérgio Mikio Koyama, Clodoaldo Annibal, Fani Cymrot Bader, David Lagakos, Gregor Matvos, Raquel de Freitas Oliveira, Josep Pijoan Mas, Mark Rosenzweig, Farzad Saidi, Amit Seru, Tony Takeda, Guilherme Yanaka, Williams Yoshioka, Toni Ricardo Eugenio dos Santos and seminar participants at FGV-SP, FGV-RJ, Princeton, Berkeley, CEMFI, Queen Mary University, Chicago Booth, NBER-DEV, Northwestern Kellogg, CEPR-BREAD. We are grateful to acknowledge financial support from the Fama-Miller Center at the University of Chicago and from the PEDL Project by the CEPR.

[†]Bustos: CEMFI, paula.bustos@cemfi.es. Garber: DEPEP, Central Bank of Brazil, gabriel.garber@bcb.gov.br. Ponticelli: University of Chicago Booth School of Business, jacopo.ponticelli@chicagobooth.edu. Juan Manuel Castro Vincenzi provided excellent research assistance.

I INTRODUCTION

The process of economic development is characterized by a reallocation of production factors from the agricultural to the industrial and service sectors. The theoretical literature has highlighted several channels through which productivity growth in agriculture can foster growth in the industrial and service sectors. First, the labour channel: productivity growth in agriculture can release workers who find employment in other sectors. Second, the demand channel: growth in agricultural income can sustain demand for industrial goods and services. Third, the finance channel: larger agricultural profits can generate savings that are reinvested in industrial projects. However, previous literature has highlighted that the experience of several low income countries appears inconsistent with the idea that high agricultural productivity leads to economic development. The literature has proposed two sets of explanations. First, scholars noted that the positive effects of agricultural productivity on economic development occur only in closed economies. This is because in economies opened to international trade a comparative advantage in agriculture can slow down industrial growth as the country specializes in the exports of agricultural products. Similarly, a globalized banking sector can channel national savings towards other countries instead of relocating them towards the local industrial and service sectors. Second, there is a large theoretical literature highlighting how market failures can retard structural transformation in developing countries (Murphy et al. 1989, Galor and Zeira 1993, Banerjee and Newman 1993, Acemoglu and Zilibotti 1997). In particular, financial frictions might constrain the reallocation of capital and thus retard the process of labour reallocation. Despite the richness of the theoretical literature, there is scarce direct empirical evidence testing the mechanisms proposed by these models.

In this paper we study the effects of productivity growth in agriculture on the supply of credit to the industrial and service sectors through the formal banking sector. For this purpose, we identify an exogenous increase in agricultural profits and trace its effects on bank lending and firm growth. In particular, we study the widespread adoption of genetically engineered (GE) soy in Brazil. We first document that in areas where, due to weather and soil characteristics, the new technology had a larger impact on potential yields, there was a sharp increase in agricultural profits. Second, we show that these areas were characterized by a faster increase in bank deposits. Third, we exploit differences in the regional structure of bank networks to trace the effect of this increase in the supply of capital on local credit markets. We find that regions that do not produce soy but are served by branches of banks with larger presence in soy producing regions experienced an increase in the supply of credit. In addition, firms in the industrial and service sectors borrowing from banks more exposed to the soy boom experienced faster growth, while we find no significant effect for firms in the agricultural sector.

One of the main difficulties faced by the empirical literature studying the reallocation

of capital across sectors is the separate identification of supply and demand shocks. In this paper, we identify exogenous increases in the supply of credit across regions in Brazil, as follows. First, we exploit the introduction of GE soy seeds to obtain exogenous variation in agricultural profits. As the new technology had a differential impact on yields depending on geographical and weather characteristics, we use differences in soil suitability across regions as a source of cross-sectional variation. For this purpose, we use data from FAO-GAEZ which reports potential yields at crop level under traditional and new agricultural technologies to obtain an exogenous measure of potential soy profitability that varies across geographical areas in Brazil. In addition, we use the date of legalization of this technology in Brazil (2003) as a source of variation across time. Second, we exploit the initial bank branch network across Brazilian regions to identify bank and branch-level exogenous increases in the supply of funds. This permits to trace the flow of funds from soy producing municipalities to non-soy producing ones.

We start by documenting the local effects of the soy boom. We find that municipalities that experience a larger increase in potential soy profitability after the legalization of GE soy seeds experienced a larger increase in the area planted with GE soy and agricultural profits. In addition, we investigate the effect of our exogenous measure of soy profitability on deposits and loans in local bank branches. This information is sourced from ESTBAN, a dataset of the Central Bank of Brazil covering detailed balance sheet information on all branches of all commercial banks registered in the country. We find that municipalities with a larger increase in potential soy profitability experienced a faster increase in bank deposits during the period under study. In particular, municipalities with a one standard deviation higher potential soy profitability experienced a 3.8% larger increase in total bank deposits. However, larger deposits did not translate into larger credit supplied by the same local branches. If anything, our point estimates indicate a decrease in local bank lending. This suggests that banks' internal capital markets are integrated within the country, and that those municipalities experiencing an increase in deposits driven by GE soy adoption were net capital exporters within their bank branch network.

Next, we analyze the role of bank branch networks in allocating funds from deposits in municipalities experiencing increases in agricultural profits (*origin*) to other municipalities (*destinations*). In particular, we attempt to identify the effect of faster increase in bank deposits on bank credit supply and its real effects on firm growth. For this purpose, we merge two datasets. First, we use loan-level data from the Credit Information System of the Central Bank of Brazil. This dataset allows us to investigate the effect of the GE-soy-driven increase in deposits of a given bank on the credit lines available to firms with pre-existing relationships with the same bank. Second, we use the Annual Social Information System (*Relação Anual de Informações Sociais*, RAIS) of the Brazilian Ministry of Labor, which provides detailed information on all formal workers and firms operating in Brazil. Using fiscal identifiers, we are able to match firms in the RAIS dataset with firms in the

Credit Information System. This combined dataset allows us to: (i) identify the *intensive margin* effect on firm growth of the GE-soy-driven credit supply shock, by exploiting pre-existing firm-bank relationships (ii) study the *extensive margin*, namely whether firms that have initially no access to bank credit are more likely to obtain it in regions that are relatively more exposed to the GE-soy-driven deposit shock through bank branch networks.

We start by analyzing the intensive margin. We find that firms with pre-existing relationships with the most affected banks took larger loans from those banks. These effects are heterogeneous across firms. In particular, for firms that initially borrowed from one single bank (single-lender firms), higher borrowing from their main lender translates into higher total borrowing, consistently with high fixed costs of opening new banking relationships. and firms. On the other hand, we find that firms that initially borrowed from multiple banks (multiple-lenders firms) largely use new credit obtained from their main lender to substitute for existing bank credit from other lenders. Overall, firms who borrowed more from their main lender grew faster in terms of employment and wage bill. Real effects are heterogeneous across firms. In particular, we find that the elasticity of firm employment to bank credit is four to five times larger for single-lender firms than for multi-lender firms, consistently with single-lender firms being more credit constrained. Finally, the effects of the credit supply shock on firm borrowing are similar for firms in all sectors, but the real effects on firm growth are larger for firms operating in manufacturing and services, while not statistically significant for firms operating in agriculture.

Next, we analyze the extensive margin. That is, we quantify the effect of the credit supply shock on credit market participation for firms with no prior credit access. In this case we can not exploit pre-existing firm-bank relationships, thus we use a second empirical strategy. We use the bank branch networks to trace the reallocation of funds from deposits in municipalities experiencing increases in agricultural profits (origin) to other municipalities (destinations). To this end, we construct a measure of municipality exposure based on the geographical location of bank branches. We find that areas more exposed to the GE- soy-driven deposit shock through bank branch networks experienced faster growth in the share of firms with credit access, especially among small firms.

Our empirical findings are supportive of several mechanisms highlighted by the theoretical literature on finance and development. First, the fact that firms with pre-existing relationships with more affected banks borrow more than other firms of the same size operating in the same local credit market and industry suggests that informational frictions constrain the optimal allocation of capital by banks. Second, the finding that these firms use these extra funds to grow faster in terms of employment and wage bill suggests that they have profitable investment opportunities. Note that this does not imply that these firms are credit constrained, in the sense that they would desire to borrow more at the equilibrium interest rate. To understand whether this is the case we would ideally

observe whether the interest rate at which they borrowed was reduced or they faced a higher credit limit. However this information is not available for the period under study. Still, our results are highly suggestive in this respect. We find that multi-lender firms tend to use the extra credit obtained from their main lender to substitute for existing credit from other lenders, while single lender firms – which are on average smaller – expand their total borrowing and grow more as a result. We also find that destination municipalities with larger increases in credit supply experienced faster growth in the share of firms with credit access, and these effects are largest for small firms.

More importantly, our empirical findings imply that agricultural productivity growth can lead to structural transformation through a financial channel. The finding that the adoption of new agricultural technologies can generate larger profits and savings deposits in local bank branches which are reallocated to other areas of the country and other sectors suggests that international capital markets are not fully integrated. As a result, an increase in national savings can lead to an increase in national investment. We find that this additional investment generates largest employment growth in manufacturing and services, while small and non-significant effects in agriculture.

Related Literature

A large literature in economics has studied the relationship between financial development and economic growth (see Levine 2005, 1997 for a detailed review), starting from the seminal contributions of Bagehot (1888) and Hicks (1969), who study the role played by financial markets during the industrial revolution in England. Related to our paper are the works by Crafts (1985) and Crouzet (1972), who explore whether agricultural productivity growth due to new technologies has been an important source of capital for other sectors during the industrial revolution. Their analysis based on historical data finds that agriculture both released and absorbed capital during the industrial revolution, so that its net contribution is ambiguous. Our paper contributes to this literature on capital reallocation across sectors, and in particular from agriculture to industry, by bringing new micro evidence from a developing country that experiences a major technological revolution in agriculture.

The first part of our empirical analysis focuses on local effects of agricultural productivity shocks. In this sense, our work is related to the empirical literature studying the links between agricultural productivity and local development. Related papers in this literature include: Foster and Rosenzweig (2004, 2007), who study the effects of new agricultural technologies (high-yielding varieties of different crops) on manufacturing growth during the Green Revolution in India; Nunn and Qian (2011), who study the effect of agricultural productivity on urbanization; as well as Hornbeck and Keskin (2014), Rajan and Ramcharan (2011). Our work is also related to papers that have studied the effect of local commodity shocks on financial development. For example, Gilje (2011) uses varia-

tion in shale gas discoveries across US counties as a shock to local deposits, and document how this shock is associated with larger growth in the number of establishments operating in sectors that rely more on external finance.¹

Our work attempts to contribute to the recent literature on the role of credit markets in developing countries. An important puzzle in this literature is that the growth in credit availability in developing countries during the last two decades has not always lead to access to finance to a broader set of the population. Instead, credit is often concentrated among the largest firms. Moreover, firms in developing countries continue to face barriers in accessing financial services. The theoretical literature has highlighted three main credit frictions that are consistent with these patterns, as discussed by Dabla-Norris et al. (2015). First, entrepreneurs in developing countries face several fixed transaction costs related to entering the formal sector and accessing bank credit. Second, moral hazard and limited liability lead to high collateral requirements for loans, which impose borrowing constraints on firms. Third, asymmetric information between banks and borrowers imposes monitoring costs which tend to be increasing in the level of leverage of firms, as a result, interest rate spreads (the difference between lending and deposit rates) tend to be much higher for poorer and younger entrepreneurs.

We expect to contribute to different strands of the literature. First, the literature on the role of factor misallocation on economic development (Banerjee and Duflo 2005, Hsieh and Klenow 2009, Caselli and Gennaioli 2013, Midrigan and Xu 2014). Second, the macroeconomic literature on financial frictions and economic development (Giné and Townsend 2004; Jeong and Townsend 2008, Buera et al. 2015, Moll 2014). This literature has laid out the theoretical mechanisms through which financial development can affect the allocation of capital and measured their importance using quantitative models. Our contribution is to provide for direct evidence of these mechanisms by observing the effect of actual exogenous credit shocks and following them using detailed micro-data. Third, the micro-economic literature on finance and development (McKenzie and Woodruff 2008; De Mel et al. 2008, Banerjee et al. 2001; Banerjee et al. 2013; Rosenzweig and Wolpin 1993). Part of this literature has directly observed the effects of exogenous credit shocks on firm growth and creation, but generally focused on micro-credit. In contrast, we focus our analysis on credit to firms of all sizes. Fourth, the literature on financial and real effects of bank liquidity shocks (Khwaja and Mian 2008, Amiti and Weinstein 2011, Schnabl 2012, Iyer et al. 2013). We contribute to this literature by using a different identification

¹Similarly, Becker (2007) exploits variation in the presence of senior citizens across counties in the US to explain variation in local bank deposits, and shows that higher local deposits are correlated with local entrepreneurial activity. More recently, Drechsler et al. (2014) exploit monetary policy changes as a shock to local deposit supply. They show that, in response to Fed funds rate increases, banks operating in areas with less bank competition tend to increase deposit spread more, with a consequent outflow of capital from the banking system. In a follow-up paper Gilje et al. (2013) show that banks more exposed to deposits windfall in shale gas counties increase mortgage lending in non-shale gas counties where they have branches.

strategy. In particular, the exogenous shock to agricultural productivity used in this paper only affects soy producing regions and expands to non-producing regions through bank networks (we discuss other potential links in the empirical strategy section). Thus, in non-soy producing regions, it only affects credit supply and not credit demand. This allows us to study real effects of credit supply shock at firm level without relying exclusively on a sample of firms with multiple bank relationships.²

Finally, this paper builds on our earlier work. In Bustos, Caprettini and Ponticelli (2016) we study the effects of the adoption new agricultural technologies in Brazil on the reallocation of labor across sectors. Our identification strategy uses the differential effect of the new technology across geographical areas. We find that increases in local agricultural productivity lead to growth in the *local* manufacturing sector. We argue that this is because technical change in soy leads to a contraction in labor demand in agriculture, causing labor to reallocate towards the manufacturing sector. The current paper complements our earlier findings in that we find that the new technology leads to larger agricultural profits and increases in local bank deposits. However, we do not find an increase in local bank lending. As mentioned above, we interpret this finding as indicative that banks' internal capital markets are nationally integrated. This indicates that the profits generated by GE soy were not channeled to the local industrial sector through the formal banking sector. This finding suggests that local manufacturing expanded due to a larger local labor supply as we argue in our earlier work. This project differs in two dimensions. First, we focus on the spatial dimension of the reallocation process. Second, we study not only the allocation of labour but also the allocation of capital. To exploit the spatial dimension of the capital allocation problem, we design a new empirical strategy which exploits the geographical structure of bank branch networks to trace the reallocation of capital across regions.

The rest of the paper is organized as follows. In section II we provide background information on the introduction of genetically engineered soy seeds in Brazil and its impact on agricultural profitability. Section III describes the data used in the empirical analysis. In section IV we present the identification strategy and discuss the empirical results of the paper. Finally, section VI concludes.

II BACKGROUND ON GENETICALLY ENGINEERED SOY IN BRAZIL

In this section we describe the technological change introduced by genetically engineered (GE) soy in Brazilian agriculture and its impact on agricultural profitability.

The main difference between GE soy seeds and traditional soy seeds is that the former are genetically engineered to resist to the application of certain herbicides. The use of

²The seminal work by Khwaja and Mian (2008) underlines the difficulty to obtain unbiased estimates of real effects of credit shocks at firm level using their methodology.

GE seeds allows farmers to adopt a new set of techniques that lowers production costs, mostly due to lower labor requirements for weed control. First, GE soy seeds facilitates the use of no-tillage planting techniques. The planting of traditional seeds is preceded by soil preparation in the form of tillage, the operation of removing the weeds in the seedbed that would otherwise crowd out the crop or compete with it for water and nutrients. In contrast, planting GE soy seeds requires no tillage, as the application of herbicide selectively eliminates all unwanted weeds without harming the crop. As a result, GE soy seeds can be applied directly on last season's crop residue, allowing farmers to save on production costs since less labor is required per unit of land to obtain the same output. Second, GE soybeans are resistant to a specific herbicide (glyphosate), which needs fewer applications: fields cultivated with GE soybeans require an average of 1.55 sprayer trips against 2.45 of conventional soybeans (Duffy and Smith 2001; Fernandez-Cornejo et al. 2002). Finally, no-tillage allows greater density of the crop on the field (Huggins and Reganold 2008).³

The first generation of GE soy seeds, the Roundup Ready variety, was commercially released in the U.S. in 1996 by the agricultural biotechnology firm Monsanto. In 1998, the Brazilian National Technical Commission on Biosecurity (CTNBio) authorized Monsanto to field-test GE soy for 5-years as a first step before commercialization in Brazil. In 2003, the Brazilian government legalized the use of GE soy seeds.⁴

The new technology experienced a fast pace of adoption in Brazil. The Agricultural Census of 2006 reports that, only three years after their legalization, 46.4% of Brazilian farmers producing soy were using GE seeds with the "objective of reducing production costs" (IBGE 2006, p.144). According to the Foreign Agricultural Service of the USDA, by the 2011-2012 harvesting season, GE soy seeds covered 85% of the area planted with soy in Brazil (USDA 2012). The Agricultural Census of 2006 reports 1355 municipalities with soy-producing farms, out of which 715 with farms declaring to use GE soy seeds.^{5,6}

Census data show that, in non-GE-soy municipalities, the median increase in agricultural profits per hectare between 1996 and 2006 was by 4.5%, while in GE-soy municipalities, the median increase in the same period was 25.4%.⁷

³Even though experimental evidence in the U.S. reports no improvements in yield of GE soy with respect to conventional soybeans (Fernandez-Cornejo and Caswell 2006), due to its cost-effectiveness this technology has spread both in the US and in Brazil.

⁴In 2003, Brazilian law 10.688 allowed the commercialization of GE soy for one harvesting season, requiring farmers to burn all unsold stocks after the harvest. This temporary measure was renewed in 2004. Finally, in 2005, law 11.105 – the New Bio-Safety Law – authorized production and commercialization of GE soy in its Roundup Ready variety (art. 35).

⁵We consider adopter a municipality with a positive amount of soy area cultivated with GE soy seeds in 2006

⁶Since borders of municipalities changed over time, the Brazilian Statistical Institute (IBGE) has defined *Área Mínima Comparável* (AMC), smallest comparable areas, which are comparable over time and which we use as our unit of observation. In what follows, we use the term municipality for AMC. Brazil has, in total, 4260 AMCs.

⁷Note that agricultural profits are only available aggregated across all agricultural activities in a given

Consistently with this increase in profitability in soy production, Bustos et al. (2016) show that the timing of adoption of GE soy seeds in Brazil coincides with a decrease in labor intensity of soy production, and a fast expansion in the area planted with soy. According to the last Agricultural Census, the area planted with soy increased from 9.2 to 15.6 million hectares between 1996 and 2006 (IBGE 2006, p.144). Similarly, Figure I shows that the area planted with soy has been growing since the 1980s, and experienced a sharp acceleration in the early 2000s.⁸

To gauge the magnitude of the soy boom and, in particular, the monetary value of soy production in Brazil relative to deposits in the banking sector, we can use data on revenues for soy producers from the Municipal Agricultural Production Survey.⁹ Total soy revenues at national level were around 6 Bn BRL in 1996, at the beginning of the period under study. This constitutes around 3% of total deposits in Brazilian banks at the time. At the peak of the soy boom years, in the mid-2000s, total soy revenues at national level were 3 to 4 times higher at around 20 Bn BRL (all values are expressed in real terms, in 2000 BRL), or 5% of total deposits in Brazilian banks at the time.

III DATA

The main data sources are: the Credit Information System of the Central Bank of Brazil for loan-level data, the Annual Social Information System of the Ministry of Labor for firm-level data, and the Municipal Bank Statistics for bank branch-level data. Additionally, we use data on agricultural outcomes from the Municipal Agricultural Production Survey and the Agricultural Census of the Brazilian Institute of Geography and Statistics, and data on potential soy yields from the Global Agro-Ecological Zones database of the Food and Agriculture Organization.

III.A BANKS, FIRMS, AND CREDIT RELATIONSHIPS DATA

The Credit Information System of the Central Bank of Brazil includes information on all credit relationships between firms and financial institutions operating in Brazil.¹⁰ We use data from the Credit Information System covering the years from 1997 to 2010.

municipality.

⁸Yearly data on area planted are from the CONAB survey. This is a survey of farmers and agronomists conducted by an agency of the Brazilian Ministry of Agriculture to monitor the annual harvests of major crops in Brazil. We use data from the CONAB survey purely to illustrate the timing of the evolution of aggregate agricultural outcomes during the period under study. In the empirical analysis, instead, we rely exclusively on data from the Agricultural Censuses which covers all farms in the country and it is representative at municipality level.

⁹The Agricultural Censuses do not report profits for producers by crop. See section III for a detailed description of these datasets.

¹⁰The Credit Information System (CRC and SCR) as well as ESTBAN are confidential datasets of the Central Bank of Brazil. The collection and manipulation of individual loan-level data and bank-branch data were conducted exclusively by the staff of the Central Bank of Brazil.

Information on each loan is transmitted monthly by financial institutions to the Central Bank. The dataset reports a set of loan and borrower characteristics, including loan amount, type of loan and repayment performance.¹¹ In the current version of the paper, we focus on total outstanding loan amount.¹² The confidential version of the Credit Information System allows us to uniquely identify both the lender (bank) and the borrower (firm) in each credit relationship.

We matched data on bank-firm credit relationships with data on firm characteristics from the Annual Social Information System (RAIS) and on bank characteristics from the Municipal Bank Statistics (ESTBAN). RAIS is an employer-employee dataset that provides individual information on all formal workers in Brazil.¹³ Using worker level data, we constructed the following set of variables for each firm: employment, wage bill, sector of operation and geographical location.¹⁴ ESTBAN reports balance sheet information at branch level for all commercial banks operating in Brazil (around 150 banks per year in our data). The main variables of interest are total value of deposits and total value of loans originated by each branch.¹⁵

III.B BROAD STYLIZED FACTS

In this section, we present some broad stylized facts on credit market participation between 1997 and 2010 that can be uncovered using our data. One advantage of our dataset with respect to existing literature is that we observe both the universe of credit relationships and the universe of formal firms. That is, we observe both firms with access to credit and firms that do not have access to credit. This allows, for example, to study the evolution of credit market participation in Brazil.

Two caveats are in order for a correct interpretation of the stylized facts presented below. First, given the institutional nature of the two datasets and the characteristics

¹¹Unfortunately, data on interest rate is only available from 2004, with the introduction of SCR, the new version of the Credit Information System.

¹²Loan amount refers to the actual use of credit lines. In this sense, our definition of access to bank finance refers to the actual use and not to the potential available credit lines of firms.

¹³Employers are required by law to provide detailed worker information to the Ministry of Labor. See Decree n. 76.900, December 23rd 1975 (Brazil 1975). Failure to report can result in fines. RAIS is used by the Brazilian Ministry of Labor to identify workers entitled to unemployment benefits (*Seguro Desemprego*) and federal wage supplement program (*Abono Salarial*).

¹⁴When a firm has multiple plants, we aggregate information on employment and wage bill across plants and assign to the firm the location of its headquarters. Whenever workers in the same firm declare to operate in different sectors, we assign the firm to the sector in which the highest share of its workers declare to operate.

¹⁵We observe three main categories of deposits: checking accounts, savings accounts and term deposits. As for loans, we observe three major categories: rural loans, which includes loans to the agricultural sector; general purpose loans to firms and individuals, which includes: current account overdrafts, personal loans, accounts receivable financing and special financing for micro-enterprises among others; and specific purpose loans which includes loans with a specific objective, such as export financing, or acquisition of vehicles. It is important to notice that ESTBAN data do not allow us to distinguish between loans to individuals vs firms. Also, we can not distinguish loans to different sectors with the exception of rural loans, which are loans directed to individuals or firms operating in the agricultural sector.

of RAIS, our analysis focuses on formal firms with at least one employee.¹⁶ Second, the Credit Information system has a reporting threshold above which financial institutions are required to transmit loan information to the Central Bank.¹⁷ In the years 1997 to 2000, this threshold was set at 50,000 BRL (around 45,000 USD in 1997). Starting from 2001 and until the end of our dataset in 2010, the threshold was lowered to 5,000 BRL (around 2,200 USD in 2001).

Figure II shows the total number of formal firms (gray bars) and the share of formal firms with access to bank credit (blue line) by year in the period between 1997 and 2010. In this Figure, we define access to bank credit as an outstanding credit balance equal or above 50,000 1997 BRL. Our objective in choosing the higher threshold for this exercise is twofold: study credit market participation on the longest time period possible given our data, and capture the share of firms that start getting large loans (rather than, for example, an overdraft on their bank account). As shown, according to this definition, 7% of formal Brazilian firms (1.4 million in the initial year) had access to bank credit in 1997. This share increased to 14% by 2010, with most of the increase occurring in the second half of the 2000s. Figure III shows how the increase in credit access ratio has been largely heterogeneous across sectors, with manufacturing and services experiencing large increases, while the share of firms with access to bank credit in agriculture has been relatively constant in the period under study.¹⁸ Finally, in Figure IV, we show the evolution of credit access ratio by firm size category. For this purpose, we use the firm size categories proposed by the Brazilian Institute of Geography and Statistics (IBGE). The IBGE defines micro firms those with between 1 and 9 workers, small firms those with between 10 and 49 workers, medium firms those with between 50 and 99 workers, and large firms those with 100 and more workers. The vast majority of Brazilian firms registered in RAIS are micro firms (84.1% of firms in our data in 1997). For these firms, the 50,000 1997 BRL reporting threshold corresponds to 1.6 times their average wage bill, making the definition of access to bank credit particularly demanding. In the years between 1997 and 2010, however, the share of micro firms with access to bank credit has tripled, going from 3% in 1997 to 9% in 2010. Small firms, for which the 50,000 1997 BRL reporting threshold corresponds to 25% of their average wage bill, also experienced a significant increase in credit access ratio, that went from 18% in 1997 to 34% in 2010.

¹⁶Self-employed are not required to report information to RAIS.

¹⁷To be more precise: the threshold applies to the total outstanding balance of a given client towards a given bank. Whenever the total outstanding balance goes above the threshold set by the Central Bank, the bank is required to transmit information on all credit operations of that client (potentially including loans whose amount is below the threshold).

¹⁸It should be noted, however, that our data covers only formal firms with at least one employee, and the agricultural sector in Brazil is still characterized by a higher degree of informality and self-employment than the manufacturing and services sectors.

III.C ADDITIONAL DATASETS

Data on area cultivated with soy and value of soy production in each municipality is from the Municipal Agricultural Production Survey (PAM, *Produção Agrícola Municipal*). PAM is a yearly survey covering information on production of the main temporary and permanent crops in Brazil. The survey is conducted at municipal level by the Brazilian Institute of Geography and Statistics through interviews with government and private agricultural firms, local producers, technicians, and other experts involved in the production and commercialization of agricultural products. The PAM survey does not contain information on the type of seeds (GE vs non-GE) used by farmers.

We source data on agricultural land planted with GE and traditional soy seeds, the value of agricultural profits, investments in agriculture and external financing from the Agricultural Census. The Agricultural Census is released at intervals of 10 years by the Brazilian Institute of Geography and Statistics (IBGE). We focus on the last two rounds of the census which have been carried out in 1996 and in 2006. Data is collected through direct interviews with the managers of each agricultural establishment and is made available by the IBGE aggregated at municipality level. It is important to notice that the measures of profits, investments and external financing do not refer specifically to soy production but are aggregated across all agricultural activities.

Finally, to construct our measure of exogenous change in soy profitability we use estimates of potential soy yields across geographical areas of Brazil from the FAO-GAEZ database. These yields are calculated by incorporating local soil and weather characteristics into a model that predicts the maximum attainable yields for each crop in a given area. In addition, the database reports potential yields under different technologies or input combinations. Yields under the low technology are described as those obtained planting traditional seeds, no use of chemicals nor mechanization. Yields under the high technology are obtained using improved high yielding varieties, optimum application of fertilizers and herbicides and mechanization. Maps displaying the resulting measures of potential yields for soy under each technology are contained in Figures V and VI.

Table I reports summary statistics of the main variables of interest used in the empirical analysis.

IV EMPIRICAL STRATEGY

In this section, we attempt to trace the reallocation of capital from the rural agricultural sector to the urban industrial and service sectors. This reallocation process takes place both across sectors and space, thus our identification strategy proceeds in three steps. First, we attempt to establish the direction of causality, from agriculture towards other sectors. For this purpose, we exploit a large and exogenous increase in agricultural productivity: namely the legalization of genetically modified soy in Brazil. We use this

variation to assess whether municipalities more affected by technical change experienced larger increases in agricultural profits and saving deposits in local bank branches. We think of these soy producing areas affected by technical change as *origin* municipalities. Second, we need to trace the reallocation of capital across space, from rural to urban areas. For this purpose, we exploit differences in the geographical structure of bank branch networks for 115 Brazilian Banks. We think of these banks as intermediaries that reallocate savings from soy producing (*origin*) municipalities to non-soy producing (*destination*) municipalities. We then use the bank branch network to construct exogenous credit supply shocks across different urban areas. Third, we trace the reallocation of capital across firms. For this purpose, we use administrative data on the credit and employment relationships for the universe of formal firms. We use this data to construct firm-level exogenous credit supply shocks using information on pre-existing firm-bank relationships.

We start by describing the identification of local effects of agricultural technical change in subsection IV.A. Next, we study the reallocation of capital through the bank branch network in subsection IV.B.

IV.A LOCAL EFFECTS

Let us first discuss the timing of legalization of GE soy seeds. GE soy seeds were commercially released in the U.S. in 1996, and legalized in Brazil in 2003. Given that the seeds were developed in the U.S., their date of approval for commercialization in the U.S., 1996, is arguably exogenous with respect to developments in the Brazilian economy. In contrast, the date of legalization, 2003, responded partly to pressure from Brazilian farmers.¹⁹ Thus, in our empirical analysis we would ideally compare outcomes before and after the first use of GE seeds in Brazil. For agricultural variables sourced from the Agricultural Census, we compare outcomes across the last two Censuses, which were carried out in 2006 and 1996. Since the 1996 Census pre-dates both legalization and the first reports of smuggling, the timing can be considered exogenous. For variables on soy production sourced from PAM, and on bank outcomes sourced from ESTBAN, outcomes are observed yearly starting from 1996. In our baseline regression we therefore compare outcomes before and after the official legalization of GE soy seeds in 2003.

Second, the adoption of GE soy seeds had a differential impact on potential yields depending on soil and weather characteristics. Thus, we exploit these exogenous differences in potential yields across geographical areas as our source of cross-sectional variation in the intensity of the treatment. To implement this strategy, we need an exogenous measure of potential yields for soy, which we obtain from the FAO-GAEZ database. These po-

¹⁹In addition, smuggling of GE soy seeds across the border with Argentina is reported since 2001. See the United States Department of Agriculture report: USDA 2001. On the smuggling of GE seeds across the Argentina-Brazil border, see also: Pelaez and Albergoni (2004), Benthien (2003) and Ortega et al. (2005).

tential yields are estimated using an agricultural model that predicts yields for each crop given climate and soil conditions. As potential yields are a function of weather and soil characteristics, not of actual yields in Brazil, they can be used as a source of exogenous variation in agricultural productivity across geographical areas. Crucially for our analysis, the database reports potential yields under different technologies or input combinations. Yields under the low technology are described as those obtained using traditional seeds and no use of chemicals, while yields under the high technology are obtained using improved seeds, optimum application of fertilizers and herbicides and mechanization. Thus, the difference in yields between the high and low technology captures the effect of moving from traditional agriculture to a technology that uses improved seeds and optimum weed control, among other characteristics. We thus expect this increase in yields to be a good predictor of the profitability of adopting GE soy seeds.

Finally, notice that our analysis is conducted at municipality level. Therefore, even if Brazil is a major exporter of soy in global markets, individual Brazilian municipalities can be considered small open economies for which variations in the international price of soy are exogenous.

More formally, our baseline empirical strategy consists in estimating the following equation:

$$y_{jt} = \alpha_j + \alpha_t + \beta \log(A_{jt}^{soy}) + \varepsilon_{jt} \quad (1)$$

where y_{jt} is an outcome that varies across municipalities and time, the subscript j identifies municipalities, t identifies years, α_j are municipality fixed effects, α_t are time fixed effects and A_{jt}^{soy} is defined as follows:

$$A_{jt}^{soy} = \begin{cases} A_j^{soy,LOW} & \text{for } t < 2003 \\ A_j^{soy,HIGH} & \text{for } t \geq 2003 \end{cases}$$

where $A_j^{soy,LOW}$ is equal to the potential soy yield under low inputs and $A_j^{soy,HIGH}$ is equal to the potential soy yield under high inputs. A potential concern with our identification strategy is that, although the soil and weather characteristics that drive the variation in A_{jt}^{soy} across geographical areas are exogenous, they might be correlated with the initial levels of economic and financial development across Brazilian municipalities. To mitigate this concern, we control for differential trends across municipalities with heterogeneous initial characteristics as follows:

$$y_{jt} = \alpha_j + \alpha_t + \beta \log(A_{jt}^{soy}) + \sum_t \Gamma_t(\text{Municipality controls}_{j,1991} \times d_t) + \varepsilon_{jt} \quad (2)$$

where: Municipality controls $_{j,1991}$ is a set of initial municipality characteristics including: income per capita (in logs), share of rural population, population density (in logs) and literacy rate. We interact this set of controls with year dummies d_t .

In the case of the outcomes sourced from the Agricultural Census, our period of interest spans the ten years between the last two censuses which took place in 1996 and 2006. We thus estimate a first-difference version of equation (1):

$$\Delta y_j = \Delta\alpha + \beta\Delta \log(A_{jt}^{soy}) + \Gamma(\text{Municipality controls}_{j,1991}) + \Delta\varepsilon_{jt} \quad (3)$$

where the outcome of interest, Δy_j is the change in outcome variables between the last two census years and:

$$\Delta \log(A_{jt}^{soy}) = \log(A_j^{soy,HIGH}) - \log(A_j^{soy,LOW})$$

IV.B REALLOCATION THROUGH BANK BRANCH NETWORK

In this section, we describe how we trace the reallocation of capital across space. In particular, we explain how we use the structure of the bank branch network across Brazilian regions to trace the flow of funds from soy producing (origin) municipalities to non-soy producing (destination) ones.

First, in subsection IV.C, we study the intensive margin, or the effects of larger credit supply on firms with prior access to credit. Our empirical strategy for the intensive margin involves two steps. In the first step we estimate the exposure of each bank to the soy boom. For this purpose, we estimate the increase in national deposits of each bank due to technical change in soy production. In the second step, we construct firm-level exogenous increases in the supply of credit and study their effects on firm growth.

Second, in subsection IV.D we study the extensive margin, or credit market participation. For this purpose, we construct exogenous credit supply increases for each *destination* municipality using differences in the geographical structure of bank branch networks.

IV.C INTENSIVE MARGIN

IV.C.1 Step I: Estimation of bank exposure to soy boom

Before describing the estimation strategy, let us just illustrate the sources of variation in bank exposure. GE soy-driven growth in deposits is a function of the geographical location of the branches of each bank before the legalization of GE soy seeds, as well as the increase in potential soy yields across these locations. To better illustrate this source of variation in bank exposure, in Figure VII we show the geographical location of the branches of two Brazilian banks with different levels of exposure to GE soy adoption. The Figure reports, for each bank, both the location of bank branches across municipalities

(red dots) and the increase in soy revenues in each municipality during the period under study (darker green indicates a larger increase). As shown, the branch network of bank A extends into areas that experienced large increase in soy revenues following the legalization of GE soy seeds. On the contrary, the branch network of bank B mostly encompasses regions with no soy production. A potential concern with this strategy is that the initial location of bank branches might have been instrumental to finance the adoption of GE soy. Thus, to construct bank exposure, we do not use the actual increase in soy revenues but our exogenous measure of potential increase in soy profitability, which only depends on soil and weather characteristics.

The first step in our empirical strategy estimates the increase in national deposits of each bank due to technical change in soy production. This national increase in deposits can be obtained by aggregating deposits collected in all local branches of each bank:

$$Deposits_b = \sum_{o \in O_b} deposits_{bo} \quad (4)$$

where $Deposits_b$ are national deposits in each bank which are obtained by summing local deposits ($deposits_{bo}$) over the set of all origin municipalities o where bank b has branches, which we define as O_b . We assume that local deposits are a function of local income. Thus, they are a function of local agricultural productivity A_o measured as yields per hectare; the endowment of agricultural land T_o ; and other municipality characteristics X_o , as follows:

$$deposits_{bo} = D_{bo}(A_o, T_o, X_o).$$

Then, we start by estimating a log-linear first-order approximation of this function. For this purpose, we estimate the increase in deposits in each bank branch due to the local increase in agricultural productivity, as follows:

$$\log(deposits)_{bot} = \alpha_b + \alpha_o + \alpha_t + \beta T_{o,t=0} \log(A_{ot}^{soy}) + \varepsilon_{bot} \quad (5)$$

where b indexes banks, o origin municipalities and t time. In turn, α_b , α_o and α_t are bank, origin municipality and time fixed effects. A_{ot}^{soy} are the FAO-GAEZ potential yields of soy in municipality o at time t , our measure of agricultural technical change and T_o is total agricultural land in municipality o in the initial year of our sample, which we source from the 1996 agricultural census. The dataset we use to obtain a measure of $deposits_{bot}$ contains information on the deposits on each branch of each bank in a given year. Thus, if a bank has more than one branch in a given municipality we aggregate the deposits of all branches of the same bank in a given year to obtain $deposits_{bot}$. We estimate equation (5) only for bank branches that were already in place in 1996, the first year of our dataset at branch level and before the legalization of GE seeds in Brazil. This ensures that we

do not capture the opening of new branches in areas with faster deposit growth due to the new technology. This new openings are more likely to occur by banks which face larger demand for funds. Thus, focusing on the pre-existing network ensures that we only capture an exogenous increase in the supply of funds.

Next, we would like to obtain the increase in national deposits of each bank due to technical change in soy. For this purpose, we could use our estimates of equation (5) to construct the predicted level of deposits in each branch $(\widehat{deposits})_{bot}$. Next, we could obtain the predicted total deposits in each bank $\widehat{Deposits}_{bot}$ by summing over the set of all municipalities where bank b has branches at t , which we define as O_{bt} . The problem with this strategy is that because we estimate equation (5) in logarithms, $(\widehat{deposits})_{bot}$ is a non-linear function of the estimated parameters. This leads to both identification and inference problems (see Appendix A for derivations and a detailed discussion).

Our strategy to avoid the identification and inference problems arising from aggregation of non-linear functions is to obtain a log-linear approximation of the change in aggregate deposits, as follows:

$$d \log (Deposits)_b = \sum_{o \in O_b} \omega_{bo} d \log (deposits)_{bo}$$

where $\omega_{bo,t=0} = \frac{deposits_{bo,t=0}}{Deposits_{b,t=0}}$, which captures the importance of each *origin* municipality as a source of deposits for bank b in the initial period. Note that we are interested in the change in aggregate deposits when the vector of potential soy yields in all municipalities $\mathbf{A} = (A_1, \dots, A_m)$ changes due to the legalization of GE soy. If we also define \mathbf{X} as the vector containing all other determinants of deposits, we can write:

$$Deposits_{bt} = D_b(\mathbf{A}_t, \mathbf{X}_t).$$

Then, we can obtain a log-linear approximation of this function as follows:

$$\begin{aligned} \log D_b(\mathbf{A}_t, \mathbf{X}_t) &= \log D_b(\mathbf{A}_{t=0}, \mathbf{X}_{t=0}) + d \log D_b(\mathbf{A}_{t=0}, \mathbf{X}_{t=0}) \\ \log D_b(\mathbf{A}_t, \mathbf{X}_t) &= \log D_b(\mathbf{A}_{t=0}, \mathbf{X}_{t=0}) + \sum_{o \in O_b} \omega_{bo,t=0} d \log D_{bo}(\mathbf{A}_{t=0}, \mathbf{X}_{t=0}) \end{aligned}$$

Next, we substitute $d \log D_{bo}$ by equation (5) and obtain:

$$\begin{aligned} \log Deposits_{b,t} &= \log Deposits_{b,t=0} + \sum_{o \in O_b} \omega_{bo,t=0} (\beta T_o) (\log A_{o,t} - \log A_{o,t=0}) \\ &\quad + (\alpha_t - \alpha_{t-1}) + \sum_{o \in O_b} \omega_{bo,t=0} (\varepsilon_{bot} - \varepsilon_{bo,t=0}) \end{aligned}$$

Add bank and time fixed effects, then:

$$\gamma_b = \log deposits_{b,t=0} + \sum_{o \in O_b} \omega_{bo,t=0} (\beta T_o) (\log A_{o,t=0})$$

$$\gamma_t = \alpha_t - \alpha_{t-1}$$

$$\eta_{bt} = \sum_{o \in O_b} \omega_{bo,t=0} (\varepsilon_{bot} - \varepsilon_{bo,t=0})$$

This is the equation we estimate:

$$\log Deposits_{bt} = \gamma_b + \gamma_t + \sum_{o \in O_b} \omega_{bo,t=0} (\beta T_o) (\log A_{o,t}) + \eta_{bt} \quad (6)$$

To illustrate the properties of this measure, let us take first differences of equation (6) between the period before (t-1) and the period after (t) legalization of GE soy:

$$\log Deposits_{bt} - \log Deposits_{bt-1} = (\gamma_t - \gamma_{t-1}) + \sum_{o \in O_b} \omega_{bo,t=0} (\beta T_o) (\log A_{o,t} - \log A_{o,t-1}) + \eta_{bt} - \eta_{bt-1}$$

The second term on the RHS is our measure of the change in national deposits of a given bank driven by soy technical change. It aims at capturing the extent to which banks are exposed to the soy-driven increase in deposits through their branch network. Indeed, differences in the initial structure of the bank branch network O_b can lead to differential effects of technical change in soy across banks. This relationship is displayed in the panel (a) of Figure VIII which contains a scatter plot of the change in predicted deposits at bank level and the aggregate actual change in soy area in municipalities where the bank has branches. As shown, banks with larger increase in predicted deposits have more branches in municipalities where the area planted with soy expanded. Note that an advantage of this specification is that the change in predicted deposits is not correlated with permanent bank characteristics, such as bank size, as reflected in the bank fixed effects which are differenced-out. In the panel (b) of Figure VIII we show that bank size as captured by log of total assets in the initial period is uncorrelated with the predicted change in national deposits driven by soy technical change.

IV.C.2 Step II

In this section we explain how we use the predicted increase in deposits in each branch due to the local increase in agricultural productivity to construct exogenous increases in credit supply. In particular, we study the effects of larger credit supply on firms with prior access to credit. For this purpose, we construct firm-level credit supply increases

using pre-existing firm-bank relationships.

To construct firm-level credit supply shocks, we assume that loans of firm i from bank b are described as follows:

$$loans_{ibt} = I_{ib,t=0} r_{bt}^\lambda u_{bit}$$

where $I_{ib,t=0}$ is an indicator variable taking the value of one when there is a bank-firm relationship at time zero. This variable captures the idea that informational frictions imply that banks are more likely to lend to firms with whom they have prior relationships. In turn, r_{bt} is the interest rate, which varies across banks due to internal capital markets: we assume that it is cheaper to finance loans with deposits than other sources such as the interbank market.

To proceed with estimation, we first condition on the sample with $I_{ib,t=0} > 0$ and take logs to obtain:

$$\log(loans_{ibt}) = \delta_i + \delta_t + \delta_b + \lambda \log r_{bt} + \varepsilon_{bit} \quad (7)$$

note that because we condition on $I_{ib,t=0} > 0$ all potential bank-firm relationships with $I_{ib,t=0} = 0$ are dropped. Thus, our estimates on this sample of firms only capture the "intensive margin." In the next sub-section we describe our empirical strategy to study the extensive margin, or credit market participation.

Second, we assume that differences in interest rates across banks are partly determined by deposits due to internal capital markets:

$$\log r_{bt} = \rho_t + \rho_b + \mu \log Deposits_{bt} + v_{bt}$$

Third, we substitute the equation above on equation 7 to obtain our main estimating equation:

$$\log(loans_{ibt}) = \delta_i + \delta_t + \delta_b + \lambda\mu \log Deposits_{bt} + e_{bit} \quad (8)$$

The equation above shows that exogenous increases in deposits can generate larger loans if $\lambda\mu > 0$: firms borrow more when the interest rate falls and banks increase their lending when they receive more deposits due to frictions in the interbank market. To identify $\lambda\mu$ we use the exogenous increases in deposits constructed in Step I – our measures of bank exposure. We therefore substitute the first stage equation (6) in our structural equation of interest (8), to obtain:

$$\log(loans_{ibt}) = \nu_i + \nu_t + \nu_b + \beta BankExposure_{bt} + \varepsilon_{bit} \quad (9)$$

where:

$$\begin{aligned}
\nu_i &= \delta_i; \\
\nu_t &= \delta_t + \lambda\mu\gamma_t; \\
\nu_b &= \delta_b + \lambda\mu\gamma_b; \\
BankExposure_{bt} &= \sum_{o \in O_b} \omega_{bo,t=0} (\beta T_o) (\log A_{o,t}).
\end{aligned}$$

This estimation strategy allows to identify the parameter $\beta = \lambda\mu$ under the assumption that the soy driven credit supply change at the bank-level is uncorrelated with credit demand changes at the firm-level.

Our identification assumption could be violated in the following cases. First, if firms credit demand grows because they face larger demand from richer soy farmers or face larger labor supply from former agricultural workers. To address this concern, we restrict our sample to firms operating in non-soy producing municipalities, that is, municipalities that do not produce soy at any point during the period under study. Second, if firms supply or buy inputs for soy production. To address this concern, we exclude firms operating in sectors directly linked to soy production through input-output linkages. This includes firms operating in the food processing industry, and firms operating in manufacturing sectors producing chemicals used as inputs in agriculture such as insecticides, herbicides, and fungicides.

A broader related concern is that different industries might be on differential growth trends due to other changes in the world economy such as increased trade with China. To address this concern, we include interactions of industry and time dummies in our specification.²⁰ A third concern is that the bank branch network connects municipalities that are also better connected through the transportation network. Thus, even if they do not produce soy they might be affected by in-migration or demand linkages. To address this concern, we estimate a specification where we control for an interaction of municipality and time dummies which absorb all the municipality-level variation across time. We then estimate the following specification:

$$\log(loans_{idsbt}) = \nu_i + \nu_t + \nu_b + \nu_{dt} + \nu_{st} + \beta BankExposure_{bt} + \varepsilon_{bit} \quad (10)$$

where the subindex d denotes the destination municipality, that is the municipality where the firm is located, and s the industry in which the firm operates. In turn, ν_{dt} are destination municipality interacted with time fixed effects, and ν_{st} are industry interacted with time fixed effects.

²⁰We use 2-digit sectors in the CNAE 1.0 Brazilian Industry Classification to construct this set of fixed effects

We are interested in assessing the real effects of this additional borrowing. In particular, we want to understand the extent to which firms use additional credit to substitute potentially more expensive loans from other banks or they use it to finance growth enhancing investments. These investments can take the form of expanding the use of capital, labor or other inputs. Because in the RAIS dataset we observe labor and the wage bill, we focus our analysis on these two inputs. However, we think that to the extent that there is some complementarity between production inputs, we expect that any investment leading to expansion of the firm is likely to be reflected in larger employment and wage bill. Thus, we analyze real effects through the following specification:

$$\log(y_{idsbt}) = \nu_i + \nu_t + \nu_b + \nu_{dt} + \nu_{st} + \beta \text{BankExposure}_{bt} + \varepsilon_{bit} \quad (11)$$

where y_{idsbt} denotes an outcome such as aggregate borrowing from all banks, the wage bill and employment in firm i , located in destination municipality d , operating in industry s at time t , and whose main lender in the initial period of the sample was bank b . Note that this specification only takes into account the increase in predicted deposits of the main lender of the firm, even if some firms borrow from more than one bank.²¹ Since the main lender is defined in the initial period and it is time invariant for each firm, the main lender fixed effects ν_b are absorbed by firm fixed effects ν_i .

IV.D EXTENSIVE MARGIN

In section IV.C we propose an identification strategy to study the effects of larger credit supply on firms with prior access to credit. In this section, we propose an identification strategy to study the effect of a credit supply increase on all firms, including those with no prior access to finance. For this purpose, we bring the analysis at municipality level and construct a measure of potential credit supply increases for each *destination* municipality using differences in the geographical structure of bank branch networks. We call this measure: destination municipality exposure.

We define our measure of destination municipality exposure as follows:

$$\text{MunicipalityExposure}_{dt} = \log \underbrace{\sum_b \frac{n_{bd}}{N_b}}_{\text{destination}} \underbrace{\sum_{o \in O_b} \frac{n_{bo,t=0}}{N_{o,t=0}} T_{o,t=0} A_{ot}^{\text{soy}}}_{\text{origin}} \quad (12)$$

Equation 12 aims at capturing to what extent destination municipality d is exposed to the soy boom in origin municipalities through the bank branch network. In particular, the second summation captures the exposure to the soy boom of bank b , where $\frac{n_{bo,t=0}}{N_{o,t=0}}$ is

²¹An alternative would be to aggregate the predicted increase in deposits for all banks operating with firm i .

the deposit market share of bank b in municipality o in the initial year, and $T_{o,t=0}A_{ot}^{soy}$ is the potential increase in soy yield (expressed in tons per hectare) in municipality o multiplied by initial agricultural land (in hectares) in the same municipality.

The first summation, instead, captures the total exposure of destination municipality d to funds coming from origin municipalities through bank networks. Notice that, in order to link origin and destination municipalities, we assume that bank's internal capital markets are perfectly integrated. This implies that deposits captured in a given municipality are first centralized at the bank level and later distributed across bank branches. To keep exogeneity of the credit supply shock, we use a neutral assignment rule for these funds across branches. That is, each bank divides these funds equally across all its branches. As a result, a municipality's share of the increase in credit supply of bank b is given by the share of bank b 's branches located in the municipality: $\frac{n_{bd}}{N_b}$. In this expression, d indexes *destination* municipalities, n_{bd} denotes the number of bank b 's branches in municipality d and N_b is the total number of branches of bank b . Note that we do not assume that banks allocate funds across branches following this rule. In practice, banks might allocate funds to respond optimally to credit demand, or can follow any other rule. We use our "neutral" assignment rule to construct an instrument which identifies the exogenous component in the actual increase in the supply of credit.

As in section IV.C, where we were studying the intensive margin, we construct the measure of destination municipality exposure only for non-soy producing municipalities, thus are not directly affected by technical change.

V EMPIRICAL RESULTS

In this section we describe the results of our empirical analysis. We start by reporting the estimates of the effect of soy technical change on *local* agricultural and banking sector outcomes in sections V.A and V.B. Our unit of observation in this first part of the empirical analysis is the municipality. We use changes in potential soy profitability at municipality level to assess whether municipalities that are potentially more affected by the adoption of GE soy seeds experienced larger increases in soy revenues and deposits in local bank branches. Then, in sections V.C and V.C.4, we trace the reallocation of capital from *origin* to *destination* municipalities using bank branch networks as described in our empirical strategy (section IV).

V.A LOCAL EFFECTS: AGRICULTURAL OUTCOMES

We start by testing the relationship between our measure of soy technical change at municipality level and a set of agricultural outcomes including: the actual adoption of GE soy seeds by Brazilian farmers, the change in agricultural profits and investment per hectare, as well as the expansion in area harvested with soy and value of soy production.

First, we study whether our measure of soy technical change predicts actual adoption of the new technology. To this end, we estimate equation (3) where the outcome of interest, Δy_j is the change in the share of agricultural land devoted to GE soy between 1996 and 2006. Note that because this share was zero everywhere in 1996, the change in the share of agricultural land corresponds to its level in 2006. Columns 1 and 2 of Table II reports the estimated coefficients. The point estimate of the coefficient on $\Delta \log(A_{jt}^{soy})$ indicates that an increase in soy technical change predicts the expansion in GE soy area as a share of agricultural area between 1996 and 2006. The magnitude of the estimated coefficient in column 2 implies that a one standard deviation increase in soy technical change corresponds to 1.5 percentage points increase in the share of agricultural land cultivated with GE soy. In columns 3 and 4 we perform a falsification test by looking at whether our measure of soy technical change explains the expansion in the area planted with traditional (non-GE) soy seeds. In this case, the estimated coefficient on $\Delta \log(A_{jt}^{soy})$ is negative and significant. This finding supports our interpretation that the measure of soy technical change captures the benefits of adopting GE soy vis-à-vis traditional soy seeds.

Next, we study whether our measure of soy technical change predicts the actual expansion of soy area as a fraction of agricultural area. To this end, we estimate equation (2) where the outcome of interest, y_{jt} is the area cultivated with soy in municipality j at time t from the PAM Survey divided by the total initial agricultural area (as observed in the Agricultural Census of 1996). Columns 1 and 2 of Table III report the results. The point estimates of the coefficients on $\log(A_{jt}^{soy})$ are positive, indicating that an increase in soy technical change predicts the expansion soy area as a share of agricultural area during the period under study. The estimated coefficient is equal to .014 when including controls, as shown in column 2. The magnitude of this estimated coefficient implies that a municipality with a one standard deviation higher increase in $\log(A_{jt}^{soy})$ experienced a 1.6 percentage points higher increase in the share of soy area over agricultural area during the period under study.

We then investigate the effect of our measure of soy technical change on agricultural profits and investment per hectare as well as revenues for soy producers. We start by estimating equation (3) on the following agricultural outcomes: agricultural profits per hectare and agricultural investment per hectare. These outcomes are sourced from the Agricultural Census of 1996 and 2006. As described in section III, these outcomes refer to all agricultural activities and not specifically to soy production. In columns 5 and 6 of Table II the outcome variable is the change in agricultural profits per hectare. The point estimate on $\Delta \log(A_{jt}^{soy})$ indicates that municipalities with a one standard deviation increase in soy technical change experienced a 10.7% larger increase in agricultural profits per hectare between 1996 and 2006. Next, in columns 7 and 8, we estimate the same equation using as outcomes the change in agricultural investment per hectare. The esti-

mated coefficient on $\Delta \log(A_{jt}^{soy})$ is positive and significant, and its magnitude is similar to the estimated coefficient when the outcome is profits per hectare. Notice that profits per hectare are 3 times as large as investment per hectare in the 1996 Agricultural Census baseline. Thus, taken together, these coefficients imply that for every R\$10 of increase in profits per hectare due to soy technical change, only around R\$3.45 are reinvested in agricultural activities.

We then estimate equation (2) where the outcome of interest, y_{jt} is the monetary value of revenues from soy production in municipality j at time t from the PAM Survey. Columns 3 and 4 of Table III report the results. The point estimates of the coefficients on $\log(A_{jt}^{soy})$ are positive, indicating that an increase in soy technical change predicts an increase in revenues from soy production during the period under study. The estimated coefficient in column 4 indicates that a one standard deviation difference in $\log(A_{jt}^{soy})$ implies a 20.5% higher increase in revenues from soy production.

V.B LOCAL EFFECTS: BANKING SECTOR OUTCOMES

In the previous sections we showed that our measure of soy technical change is a good predictor of the adoption of GE soy seeds, the expansion of soy area and the increase of revenues for soy producers.

Additionally, we showed evidence that municipalities with larger increase in soy technical change also experienced larger increases in agricultural profits. In what follows, we investigate what was the use of agricultural profits. In principle, they could have been reinvested in agriculture, channeled to consumption or to savings. In the previous section we showed evidence that agricultural profits were only partly (34.5%) reinvested in agricultural activities. If saved, they could have taken the form of informal lending arrangements or could have been channeled through the banking sector. Finally, they could have been lent locally, nationally or internationally. To understand these issues, we investigate the effect of our measure of soy technical change on deposits in local bank branches and on loans originated by the same bank branches. We estimate equation (2) where y_j is the log of the total value of bank deposits or bank loans originated by bank branches located in municipality j . Data on bank outcomes is sourced from the ESTBAN dataset and it is described in section III.

Columns 1 and 2 of Table IV report the results when the outcome variable is total bank deposits, which we define as the sum of deposits in checking accounts (demand deposits), deposits in saving accounts (saving deposits) and term deposits. The estimates indicate that municipalities with higher increase in soy technical change experienced a larger increase in total bank deposits during the period under study. The magnitude of the effect is economically significant: the estimated coefficient in column 2 indicates that a municipality with a one standard deviation higher potential soy profitability experienced a

6.9% larger increase in total bank deposits.²² We can use the estimates obtained in Table III and IV to back out the elasticity of bank deposits to revenues from soy production. The implied elasticity can be computed by dividing the estimated coefficient on soy technical change when the outcome is total deposits (0.061) by the estimated coefficient on the same variable when the outcome is revenues from soy production (0.181). Our estimates indicate that a 1% increase in revenues for soy farmers is associated with a 0.34% increase in total bank deposits at municipality level.²³

Finally, columns 3 and 4 of Table IV report the results of estimating equation (2) when the outcome variable is the total value of lending originated by bank branches located in municipality j . Lending includes loans to individuals and firms, which we cannot separate in ESTBAN. As shown, the estimated effect of soy technical change on total bank lending at municipality level is negative. This suggests that municipalities that experienced larger increase in potential soy profitability are net "exporters" of capital in their bank branch network.

Additional Results: Timing of the Effect on Agricultural and Banking Sector Outcomes

In this section we investigate whether our exogenous measure of soy technical change captures the right timing of the introduction of GE soy seeds.

When we estimate equation (2) as described in section IV, we implicitly assume that soy production experienced technical change in 2003. This is because the measure of potential soy yield (A_{jt}^{soy}) is assumed to change from its level under low inputs to its level under high inputs in correspondence with the legalization of GE soy seeds in Brazil. The outcomes sourced from the PAM are available at yearly level. Therefore, for these outcomes, we can investigate whether the measure of soy technical change captures the right timing of the introduction of GE soy seeds by running the following equation:

$$y_{jt} = \alpha_j + \alpha_t + \sum_t \beta_t (\Delta \log(A_j^{soy}) \times d_t) + \varepsilon_{jt} \quad (13)$$

where d_t is a time dummy and $\Delta \log A_j^{soy}$ is a time invariant measure of the change in potential yield when soy production switches from low to high inputs:

$$\Delta \log A_j^{soy} = \log(A_j^{soy,HIGH}) - \log(A_j^{soy,LOW})$$

²²In additional tables not reported here we studied whether this effect varies for different types of bank deposits. We find that the effect of potential soy profitability on deposit is concentrated on demand and saving deposits. Demand deposits are unremunerated, while saving accounts are remunerated at a rate that is lower than the interbank rate (around half). As such, these deposits constitute a cheap source of financing for Brazilian banks and are the most common way of saving, especially in rural areas of Brazil. On the other hand, we find no effect on term deposits.

²³This estimated elasticity is statistically different from zero. See Table XII which reports estimate and standard error in a standard instrumental variable setting.

In Figure IX we plot the estimated β_t coefficients along with their 95% confidence intervals when the outcome variables are: soy area as a share of agricultural area (left graph) and total bank deposits (right graph).²⁴ The timing of the effect of ΔA_j^{soy} on both outcomes is broadly consistent with the timing of the legalization of GE soy seeds. However, as shown, the estimated β_t coefficients are positive and statistically different from zero starting from 2002. This indicates that the positive effect of soy technical change on the expansion of soy area and total bank deposits started before the official legalization of GE soy seeds in 2003. We attribute this effect to the presence of smuggling of GE soy seeds from Argentina already detected in the year before the official liberalization (USDA 2001).

V.C REALLOCATION THROUGH BANK BRANCH NETWORK: INTENSIVE MARGIN

In this section we explore whether larger increases in bank deposits due to soy technical change affected credit supply in non soy-producing areas through bank branch networks. As explained in section IV, this paper aims at tracing the reallocation of capital from rural agricultural areas to urban industrial and services areas. In this process of reallocation, we think of soy producing areas that are more affected by technical change as *origin* municipalities, and of non-soy producing areas as *destination* municipalities. Origin and destination municipalities are connected through the branch networks of Brazilian banks.

We start by constructing a measure of bank exposure to the extra deposits generated by soy technical change for each bank. To this end, we estimate the increase in deposits in each bank branch due to the local increase in potential soy productivity as described in equation (5). In this specification, our unit of observation is a bank branch.²⁵ Table V reports the results of estimating equation (5) for three outcomes: total deposits in a given bank branch, total lending originated by the same branch, and the ratio of deposits minus loans divided by total liabilities of the same branch. The rationale of this last variable is to test whether branches more affected by the soy technological shock were net exporters of liquidity within their bank network.

Our primary outcome of interest is total deposits in a given bank branch. Results for this outcome are reported in column 1 of Table V. The estimated coefficient on soy technical change when the outcome is total deposits is positive and statistically significant. Its magnitude indicates that bank branches with a one standard deviation higher exposure to soy technical change experienced an 8.4% larger increase in deposits. As shown in columns 2 and 3, branches with higher exposure to soy technical change experienced no differential increase in total loans, and were net capital exporters within their bank network. Notice that, to construct the soy-driven increase in deposits of each bank

²⁴All these regressions include municipality and bank controls interacted with time fixed effects.

²⁵To be more precise, our unit of observation is a bank-municipality. When a bank has multiple branches in the same municipality, their balance sheet are aggregated in one observation in the ESTBAN dataset.

described in section IV.B, we use the estimated coefficient obtained in column 1 of Table V.

We then study the effect of the soy-driven increase in deposits of each bank — or “bank exposure to the soy boom” — on a set of firm level outcomes. For each firm, we focus on the bank exposure of its main lender, i.e. the bank from which a firm borrows the larger share of its outstanding loan balance. To minimize the concern that endogenous formation of firm-bank relationships — which could depend from a bank exposure to the soy boom — might affect our results, we proceed as follows. We define the main lender of each firm using exclusively data from the years 2001 and 2002, i.e. before the legalization of GE soy in Brazil, which occurred in 2003.²⁶ Then, we use the exposure of the pre-2003 main lender for all years in which a firm is present in our sample, no matter whether the firm is borrowing or not from its initial main lender in the years after GE soy legalization.

In terms of firm-level outcomes, we focus on four main variables: loans from main lender, defined as the log of the monetary value of firm borrowing from its pre-2003 main lender; loans from all lenders, defined as the log of the monetary value of firm borrowing from all lenders; employment, defined as the log of the yearly average number of workers; and wage bill, defined as the log of the monetary value of the firm total wage bill. The first two outcomes are sourced from the Credit Information System of the Central Bank of Brazil, while the second two outcomes — our measures of firm size — are sourced from RAIS. Notice that, to construct our measure of bank loans for each firm, we use all loans above the 5,000 BRL threshold. At the expense of restricting our analysis to a shorter time period (2001 to 2010), this threshold allows us to minimize the sample selection we face when using the 50,000 BRL threshold. Finally, as discussed in section IV.B, we apply two further restrictions to our sample. First, we restrict our sample to firms operating in municipalities that do not produce soy at any point in time between 2001 and 2010. Second, we exclude firms operating in the soy sector (which might be incorporated in municipalities where there is no soy production) and firms operating in sectors that are directly linked to soy production through input-output linkages. This last category includes firms operating in the food processing industry, and firms operating in manufacturing sectors producing chemicals used as inputs in agriculture such as insecticides, herbicides, and fungicides.

V.C.1 Average Effects

Table VI shows the results of estimating equation (11), described in section IV and reported below for convenience:

$$\log(y_{idsbt}) = \nu_i + \nu_t + \nu_b + \nu_{dt} + \nu_{st} + \beta \text{BankExposure}_{bt} + \varepsilon_{bit}$$

²⁶Results are robust to an alternative definition of main lender that uses exclusively year 2001.

where i indexes firms, d indexes the destination municipality where the firm is located, s indexes a sectors, b indicates banks and t indexes time. The coefficient of interest in this specification is the one on bank exposure (β), which captures the effect of main lender exposure on firm-level outcomes. We interpret main lender exposure as an exogenous credit supply shock at firm level.

Table VI reports the estimated β under two specifications for each outcome. In the first specification, we regress a firm-level outcome in logs on firm and time fixed effects, the main lender exposure, and an interaction of municipality fixed effects with time fixed effects. In the second specification, we also introduce an interaction of sector fixed effects with time fixed effects.²⁷

We find positive and large effects of bank exposure on firm borrowing from their main lender. In terms of economic magnitude, the estimated coefficient in column (2) indicates that a firm whose main lender has a 1 standard deviation higher increase in deposits due to soy technical change experienced a 14% larger increase in borrowing from its main lender (or 8.5% of a standard deviation). As shown in columns (3) and (4), on average, larger borrowing from main lender does not translate into larger total borrowing at firm level. This suggests that firms at least in part substitute borrowing from other lenders with credit offered by their main lender when the latter receives a positive deposit shock. We investigate this potential substitution effect in detail in section V.C.2, and show that the effect on total borrowing differ across firms depending on their initial number of lending relationships.

We find positive real effects on firm size. Firms whose main lender has a larger exposure to the soy-driven deposit increase experienced larger growth in employment (column 6) and wage bill (column 8). The magnitude of the estimated coefficients indicates that a firm whose main lender has a 1 standard deviation higher increase in deposits due to soy technical change experienced a 1.2% larger increase in employment and an almost 2% larger increase in wage bill. In addition, we can use the estimates obtained in Table VI to back out the elasticity of firm size to bank credit from main lender. The estimates in column (2) and (8) indicate that a 1% increase in bank credit from main lender is associated with a 0.12% increase in firm size as measured by its wage bill.²⁸

V.C.2 Heterogeneous Effects by Number of Lending Relationships

The results presented in section V.C.1 show that, on average, higher borrowing from main lender does not translate into larger total borrowing from all lenders. In this section

²⁷Sector fixed effects are 2-digits sectors according to the Brazilian CNAE 1.0 classification. This is a finer classification than the one used in section V.C.3 when we study results separately for agriculture, manufacturing and services. Firms in our sample are present in 56 2-digit CNAE 1.0 sectors.

²⁸This implied elasticity is computed by dividing the estimated coefficient on main lender exposure when the outcome is firm wage bill by the estimated coefficient on the same variable when the outcome is bank loans from the main lender.

we study whether our effects are heterogeneous for firms that have different initial numbers of bank relationships. To the extent that starting a new bank relationship has a fixed cost – for example due to asymmetric information – we expect to see lower substitution effect of bank credit from other lenders with credit from the main lender in firms that initially have a single bank relationship. We therefore split our sample into firms that, in the years before the introduction of the new soy technology, borrowed from a single versus multiple lenders. In 2001 and 2002, one-third of the firms used in our main regression had a single bank relationship. Firms with a single bank relationship in the pre-2003 years tend to be smaller than multi-bank relationships firms in terms of average number of employees (18 versus 46) and wage bill (their average wage bill is 33% of the wage bill of multi-relationship firms). They also tend to have smaller loans from their main lender, with the median firm borrowing 10,000 R\$ versus the 43,000 R\$ for the median multi-relationship firm.

Table VII shows the results obtained splitting the sample into single versus multi-bank relationships firms. We focus on the same four outcomes presented in Table VI and only present results obtained with our most conservative specification which includes both municipality and sector fixed effects interacted with year fixed effects. We find two important results. First, when focusing on firms with a single bank relationship in the pre-2003 period, we find positive and large effects of bank exposure on firm borrowing from both their main lender and from all lenders. The coefficients in columns (1) and (2) are almost identical, suggesting the number of bank relationships is relatively sticky over time for single-lender firms in our sample. On the other hand, firms with initially multiple bank relationship seem to largely use new credit obtained from the main lender to substitute for existing bank credit from other lenders. Second, real effects are largely heterogeneous across firms with different initial numbers of banking relationships and largely concentrated in single-lender firms. The estimated coefficients in columns (3) and (4) of Table VII indicate that single-lender firms that borrow from a 1 standard deviation more exposed banks, experienced 5.1% larger increase in employment and 5.5% larger increase in total wage bill. On the other hand, multi-lender firms with the same exposure to the soy-driven deposit shock, experienced 0.9% larger increase in employment and 1.5% larger increase in wage bill. Taken together, these two results are consistent with single-lender firms being credit constrained, while multi-lender firms being credit unconstrained.

V.C.3 Heterogeneous Effects by Sector

In Table VIII we report the results of estimating equation (11) by sector of operation of each firm. The four sectors we focus on are: agriculture, manufacturing, services and other sectors.²⁹ As shown, the effects of bank exposure on firm borrowing from their

²⁹Services include: construction, commerce, lodging and restaurants, transport, housing services, domestic workers and other personal services. We exclude banks and other firms in the financial sector.

main lender are positive, precisely estimated and similar in size across all sectors. Real effects are positive in all sectors but statistically significant only in manufacturing and services. In particular, the estimates suggest that, for a similar increase in borrowing due to their main lender exposure, manufacturing and services firms experience a significantly higher increase in size with respect to firms operating in agriculture. More specifically, the elasticity of firm size to bank loans from the main lender is twice as large in manufacturing and three times as large in services with respect to firms operating in agriculture: it is equal to 0.28 for manufacturing, 0.5 in services and 0.14 in agriculture.

Finally, in Table IX we report the results obtained estimating equation (11) by sector *and* initial number of bank relationships of each firm. As shown, when studying each sector individually, results are consistent with those presented in Table VII. That is, we find evidence of substitution for multi-lender firms while single-lender firms experience a net increase in total bank loans. Second, real effect are concentrated in single-lender firms within each sector, and are precisely estimated in manufacturing and services while not statistically different from zero in agriculture.

V.C.4 Reallocation Through Bank Branch Network: Extensive Margin

In this section we study the effect of municipality exposure to the soy boom through the bank branch network on firm access to bank credit. To this end, we estimate the following equation:

$$I_{dt} = \alpha_d + \alpha_t + \beta \text{MunicipalityExposure}_{dt} + \varepsilon_{dt} \quad (14)$$

Where the measure of municipality exposure is defined as in section IV and the outcome variable I_{dt} is the share of firms with access to bank credit in destination municipality d and year t . We define access to bank credit using the 50,000 1997 BRL threshold in the Credit Information System. Under this definition, a firm is considered as having access to bank credit if its outstanding loan balance with a bank in a given year is greater or equal to 50,000 1997 BRL. As explained in subsection III.B, the rationale of using this higher threshold when studying access to bank finance is to capture access to large term loans rather than, for example, short term finance in the form of current account overdrafts. As in the previous sections, we focus exclusively on non-soy producing municipalities, and we exclude from our measure of I_{dt} firms that operate in sectors linked to soy production through IO linkages.

Table X reports the results of estimating equation (14). We find that municipalities with larger exposure to the soy boom through the bank network experience larger increase

Other sectors include: public administration, education, health, international organizations, extraction, and public utilities.

in firm access to bank credit. The magnitude of the estimated coefficient reported in column (1) implies that a municipality with a 1 standard deviation larger exposure to the soy boom experienced a 2 percentage points larger increase in the share of firms with access to bank credit (36% of a standard deviation in I_{dt}). In columns (2), (3), (4) and (5) we report the results of estimating equation (14) when the outcome variable is the share of firms with access to bank credit operating in, respectively: agriculture, manufacturing, services and other sectors. We find positive and significant effects on access to bank credit for firms operating in manufacturing and services, while the effect is not precisely estimated for firms operating in agriculture and other sectors. In terms of magnitude, the estimated coefficients reported in columns (3) and (4) imply that a municipality with a 1 standard deviation larger exposure to the soy boom experienced a 2.7 percentage points larger increase in the share of manufacturing firms with access to bank credit, and a 1.5 percentage points larger increase in the share of services firms with access to bank credit. Finally, in column (6) to (9), we report the results of estimating equation (14) when the outcome variable is the share of firms with access to bank credit in different firm size categories: micro, small, medium size and large firms, all defined as in section III. Here we find positive and significant effects for micro and small firms, while the estimates are not statistically different from zero for medium size and large firms.

VI CONCLUDING REMARKS

In this paper we study the effect of new agricultural technologies on reallocation of capital across regions, sectors and firms. The empirical analysis is focused on the widespread adoption of genetically engineered (GE) soy in Brazil. This technology allows farmers to obtain the same yield with lower production costs, thus increasing agricultural profits.

We find that municipalities that are predicted to experience a larger increase in soy profitability after the legalization of GE soy seeds are more likely to adopt this new technology and experience a larger increase in agricultural profits. At local level, we find a positive effect of GE soy adoption on deposits in local bank branches. Our evidence suggests capital was not lent locally. Instead, branches located in soy producing areas were net capital exporters within their bank network, and capital was reallocated towards other regions. In these capital destination regions, the increase in credit supply affected firms' credit access through the extensive and intensive margin. First, regions with more bank branches receiving funds from soy areas experienced an increase in credit market participation of small and medium sized firms. In addition, banks experiencing faster deposit growth in soy areas increased their lending to firms with whom they had preexisting relationships. In turn, these firms grew faster in terms of employment and wage bill. Our estimates imply that the elasticity of firm growth to credit is largest in the manufacturing

and services sector, while we do not find statistically significant effects in the agricultural sector. These findings suggest that agricultural productivity growth can lead to structural transformation through a financial channel.

REFERENCES

- Acemoglu, D. and F. Zilibotti (1997). “Was Prometheus Unbound by Chance? Risk, Diversification, and Growth”. *Journal of political economy* 105(4), 709–751.
- Amiti, M. and D. Weinstein (2011). Exports and financial shocks. *The Quarterly Journal of Economics* 126(4), 1841–1877.
- Bagehot, W. (1888). *Lombard Street: A description of the money market*. Kegan, Paul & Trench.
- Banerjee, A. and E. Duflo (2005). “Growth Theory Through the Lens of Development Economics”. *Handbook of Economic Growth* 1, 473–552.
- Banerjee, A., D. Karlan, and J. Zinman (2001). Six randomized evaluations of microcredit: Introduction and further steps. *American Economic Journal: Applied Economics* 7(1), 1–21.
- Banerjee, A. V., E. Duflo, R. Glennerster, and C. Kinnan (2013). The miracle of micro-finance? evidence from a randomized evaluation.
- Banerjee, A. V. and A. F. Newman (1993). “Occupational Choice and the Process of Development”. *Journal of political economy*, 274–298.
- Becker, B. (2007). Geographical segmentation of us capital markets. *Journal of Financial economics* 85(1), 151–178.
- Benthien, P. F. (2003). As sementes transgênicas no brasil: da proibição à liberação. *Revista Vernáculo* 1.
- Brazil (1975). Decree N. 76,900.
- Buera, F. J., J. P. Kaboski, and Y. Shin (2015). “Entrepreneurship and Financial Frictions: A Macro-Development Perspective”.
- Bustos, P., B. Caprettini, and J. Ponticelli (2016). “Agricultural Productivity and Structural Transformation: Evidence from Brazil”. *American Economic Review*, forthcoming.
- Caselli, F. and N. Gennaioli (2013). Dynastic management. *Economic Inquiry* 51(1), 971–996.
- Crafts, N. F. (1985). *British economic growth during the industrial revolution*. Clarendon Press Oxford.
- Crouzet, F. (1972). *Capital Formation in the Industrial Revolution*. Methuen.
- Dabla-Norris, E., Y. Ji, R. M. Townsend, and D. F. Unsal (2015). “Distinguishing Constraints on Financial Inclusion and Their Impact on GDP, TFP, and Inequality”. *NBER Working Paper* (20821).
- De Mel, S., D. McKenzie, and C. Woodruff (2008). Returns to capital in microenterprises: evidence from a field experiment. *The Quarterly Journal of Economics*, 1329–1372.

- Drechsler, I., A. Savov, and P. Schnabl (2014). “The Deposits Channel of Monetary Policy”. *Working Paper*.
- Duffy, M. and D. Smith (2001). “Estimated Costs of Crop Production in Iowa”. *Iowa State University Extension Service FM1712*.
- Fernandez-Cornejo, J. and M. Caswell (2006). “The First Decade of Genetically Engineered Crops in the United States”. *United States Department of Agriculture, Economic Information Bulletin 11*.
- Fernandez-Cornejo, J., C. Klotz-Ingram, and S. Jans (2002). “Estimating Farm-Level Effects of Adopting Herbicide-Tolerant Soybeans in the USA”. *Journal of Agricultural and Applied Economics 34*, 149–163.
- Foster, A. D. and M. R. Rosenzweig (2004). “Agricultural productivity growth, rural economic diversity, and economic reforms: India, 1970–2000”. *Economic Development and Cultural Change 52*(3), 509–542.
- Foster, A. D. and M. R. Rosenzweig (2007). “Economic development and the decline of agricultural employment”. *Handbook of development economics 4*, 3051–3083.
- Galor, O. and J. Zeira (1993). “Income Distribution and Macroeconomics”. *The review of economic studies 60*(1), 35–52.
- Gilje, E. (2011). “Does Local Access to Finance Matter? Evidence from US Oil and Natural Gas Shale Booms”. *Working paper*.
- Gilje, E., E. Loutskina, and P. E. Strahan (2013). “Exporting Liquidity: Branch Banking and Financial Integration”. *NBER Working paper*.
- Giné, X. and R. M. Townsend (2004). “Evaluation of financial liberalization: a general equilibrium model with constrained occupation choice”. *Journal of Development Economics 74*(2), 269–307.
- Hicks, J. R. (1969). A theory of economic history. *OUP Catalogue*.
- Hornbeck, R. and P. Keskin (2014). The historically evolving impact of the ogallala aquifer: Agricultural adaptation to groundwater and drought. *American Economic Journal: Applied Economics 6*(1), 190–219.
- Hsieh, C. and P. Klenow (2009). “Misallocation and Manufacturing TFP in China and India”. *Quarterly Journal of Economics 124*(4), 1403–1448.
- Huggins, D. R. and J. P. Reganold (2008). “No-Till: the Quiet Revolution”. *Scientific American 299*, 70–77.
- IBGE (2006). “*Censo Agropecuário 2006*”. Rio de Janeiro, Brazil: Instituto Brasileiro de Geografia e Estatística (IBGE).
- Iyer, R., J.-L. Peydró, S. da Rocha-Lopes, and A. Schoar (2013). Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007–2009 crisis. *Review of Financial studies*, hht056.

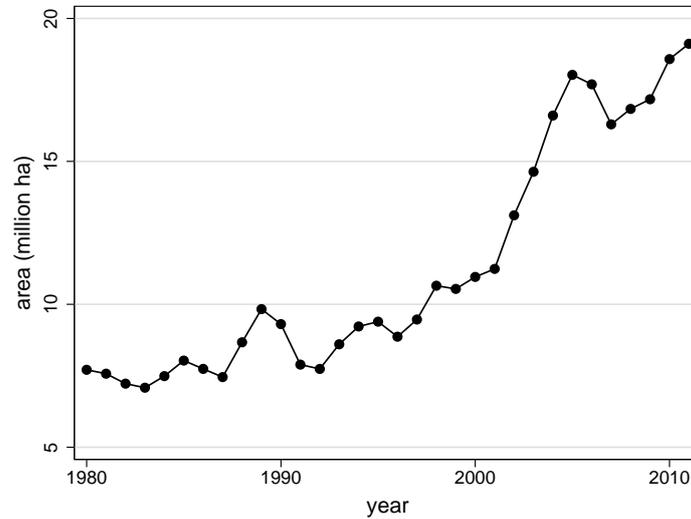
- Jeong, H. and R. M. Townsend (2008). “Growth and inequality: Model evaluation based on an estimation-calibration strategy”. *Macroeconomic dynamics* 12(S2), 231–284.
- Khwaja, A. I. and A. Mian (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *The American Economic Review*, 1413–1442.
- Levine, R. (1997). Financial development and economic growth: views and agenda. *Journal of economic literature* 35(2), 688–726.
- Levine, R. (2005). “Finance and Growth: Theory and Evidence”. *Handbook of Economic Growth* 1, 865–934.
- McKenzie, D. and C. Woodruff (2008). Experimental evidence on returns to capital and access to finance in Mexico. *The World Bank Economic Review* 22(3), 457–482.
- Midrigan, V. and D. Y. Xu (2014). Finance and misallocation: Evidence from plant-level data. *American Economic Review* 104(2), 422–58.
- Moll, B. (2014). Productivity losses from financial frictions: Can self-financing undo capital misallocation? *The American Economic Review* 104(10), 3186–3221.
- Murphy, K. M., A. Shleifer, R. Vishny, et al. (1989). Income distribution, market size, and industrialization. *The Quarterly Journal of Economics* 104(3), 537–564.
- Nunn, N. and N. Qian (2011). The potato’s contribution to population and urbanization: Evidence from a historical experiment. *The Quarterly Journal of Economics* 126(2), 593–650.
- Ortega, E., O. Cavalett, R. Bonifácio, and M. Watanabe (2005). Brazilian soybean production: energy analysis with an expanded scope. *Bulletin of Science, Technology & Society* 25(4), 323–334.
- Paxson, C. (1992). “Using weather variability to estimate the response of savings to transitory income in Thailand”. *The American Economic Review*, 15–33.
- Pelaez, V. and L. Albergoni (2004). Barreiras técnicas comerciais aos transgênicos no Brasil: a regulação nos estados do sul. *Indicadores econômicos FEE* 32(3), 201–230.
- Petersen, M. A. and R. G. Rajan (2002). “Does Distance Still Matter? The Information Revolution in Small Business Lending”. *The Journal of Finance* 57(6), 2533–2570.
- Rajan, R. G. and R. Ramcharan (2011). Land and credit: A study of the political economy of banking in the United States in the early 20th century. *The Journal of Finance* 66(6), 1895–1931.
- Rosenzweig, M. R. and K. I. Wolpin (1993). “Credit market constraints, consumption smoothing, and the accumulation of durable production assets in low-income countries: Investments in bullocks in India”. *Journal of Political Economy*, 223–244.
- Schnabl, P. (2012). The international transmission of bank liquidity shocks: Evidence from an emerging market. *The Journal of Finance* 67(3), 897–932.

USDA (2001). "Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops". United States Department of Agriculture, Economic Research Service.

USDA (2012). "Agricultural Biotechnology Annual". United States Department of Agriculture, Economic Research Service.

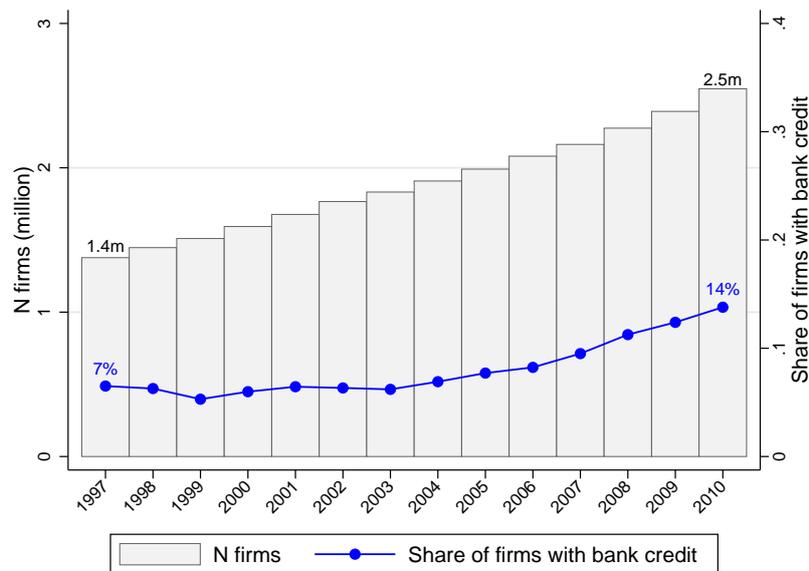
FIGURES AND TABLES

FIGURE I: EVOLUTION OF AREA PLANTED WITH SOY IN BRAZIL



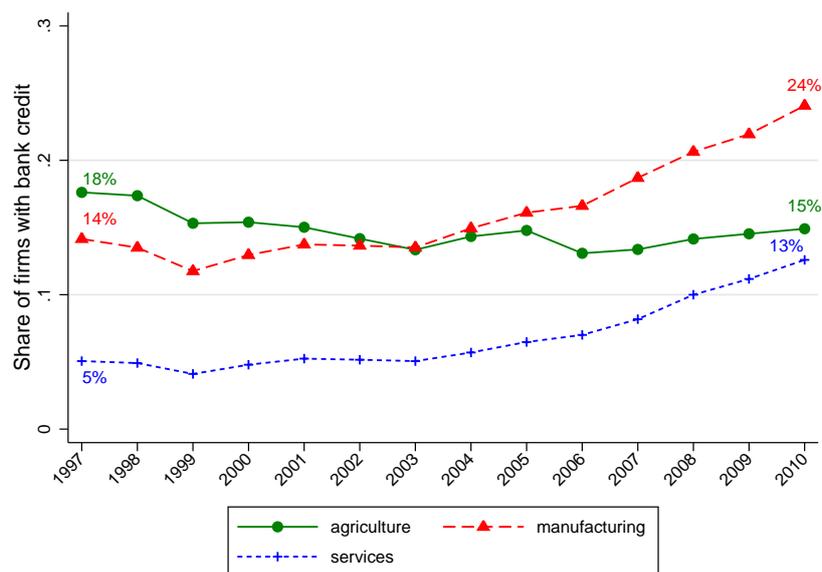
Notes: Data source is CONAB, Companhia Nacional de Abastecimento, which is an agency within the Brazilian Ministry of Agriculture. CONAB carries out monthly surveys to monitor the evolution of the harvest of all major crops in Brazil: the surveys are representative at state level and are constructed by interviewing on the ground farmers, agronomists and financial agents in the main cities of the country. All data can be downloaded at: [http://www.conab.gov.br/conteudos.php?a=1252&t=.](http://www.conab.gov.br/conteudos.php?a=1252&t=)

FIGURE II: SHARE OF FIRMS WITH BANK CREDIT
BRAZIL: 1997-2010



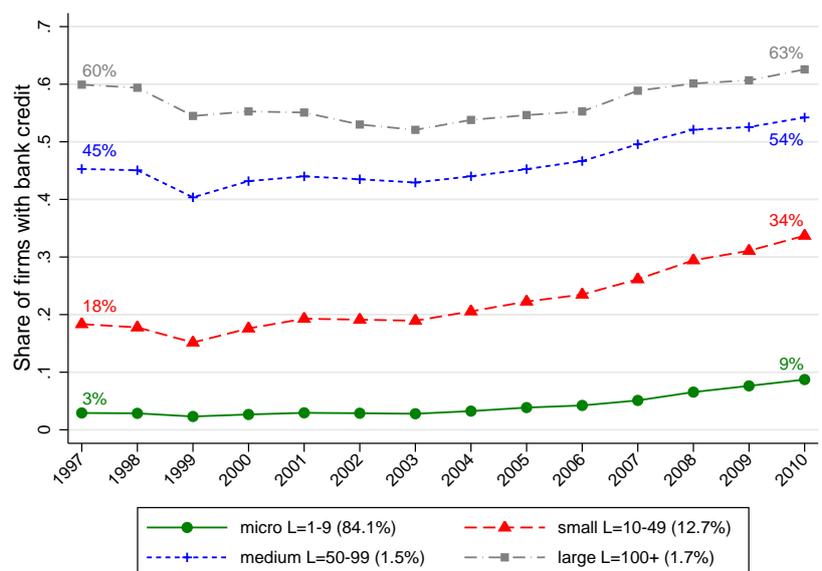
Notes: Sources are the Credit Information System of the Central Bank of Brazil and RAIS, authors' calculation from micro-data. Access to bank credit is defined as an outstanding credit balance of at least 50,000 1997 BRL.

FIGURE III: SHARE OF FIRMS WITH BANK CREDIT: BY SECTOR
BRAZIL: 1997-2010



Notes: Sources are the Credit Information System of the Central Bank of Brazil and RAIS, authors' calculation from micro-data. Access to bank credit is defined as an outstanding credit balance of at least 50,000 1997 BRL. Services include: construction, commerce, lodging and restaurants, transport, housing services, domestic workers.

FIGURE IV: SHARE OF FIRMS WITH BANK CREDIT: BY FIRM SIZE
BRAZIL: 1997-2010



Notes: Sources are the Credit Information System of the Central Bank of Brazil and RAIS, authors' calculation from micro-data. Access to bank credit is defined as an outstanding credit balance of at least 50,000 1997 BRL. Numbers in parenthesis are the percentage of firms in each size category in 1997.

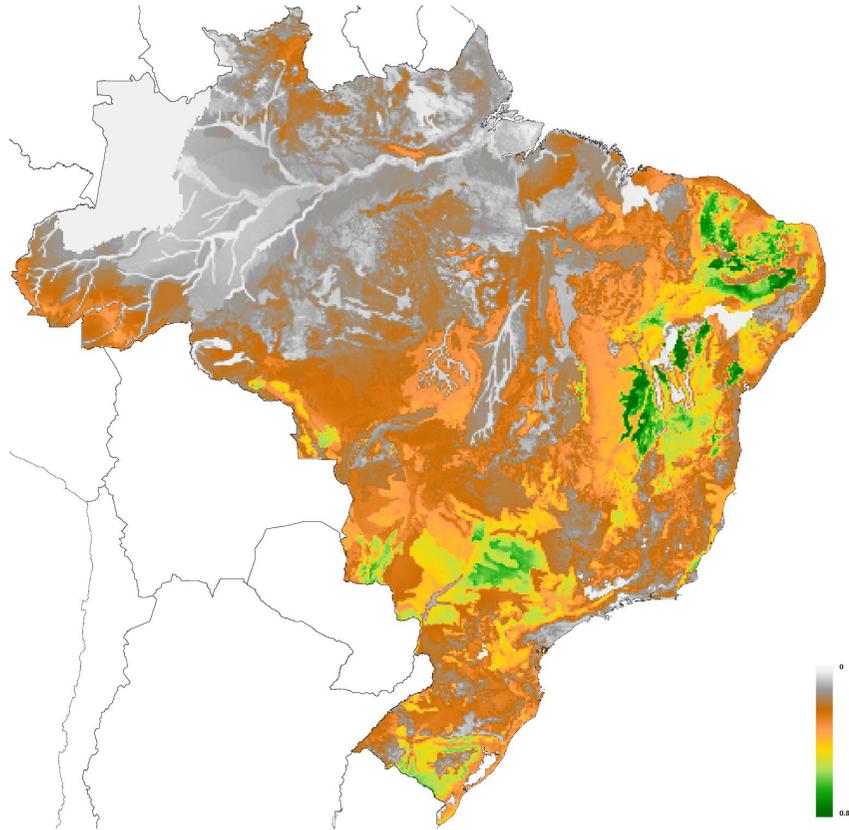


FIGURE V: Potential soy yield under low agricultural technology

Notes: Data from FAO-GAEZ.

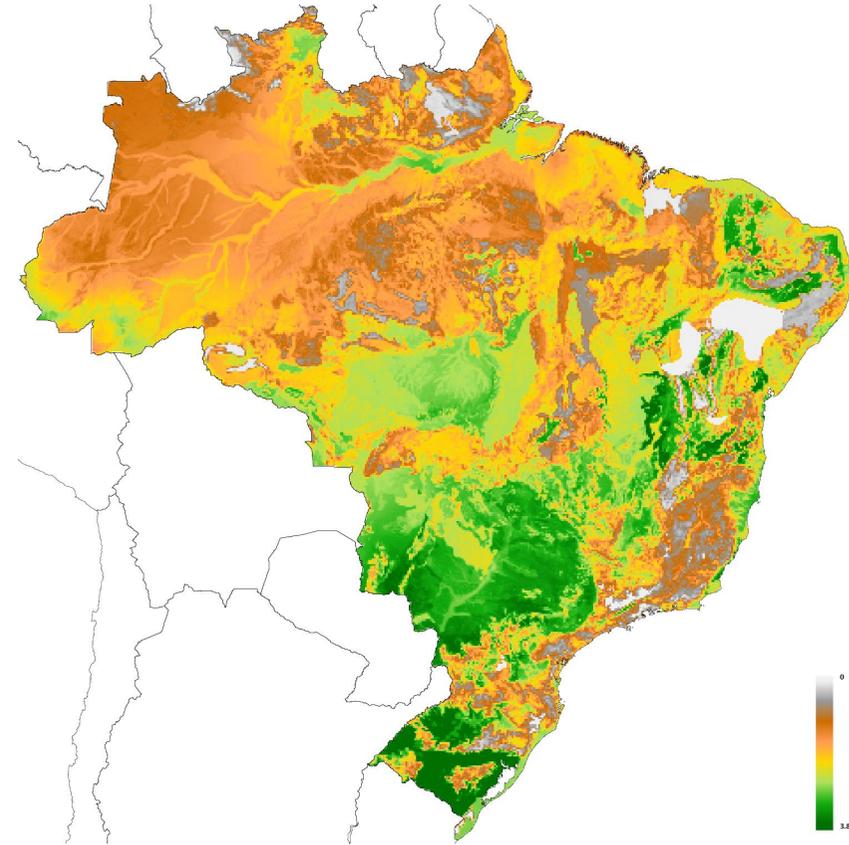
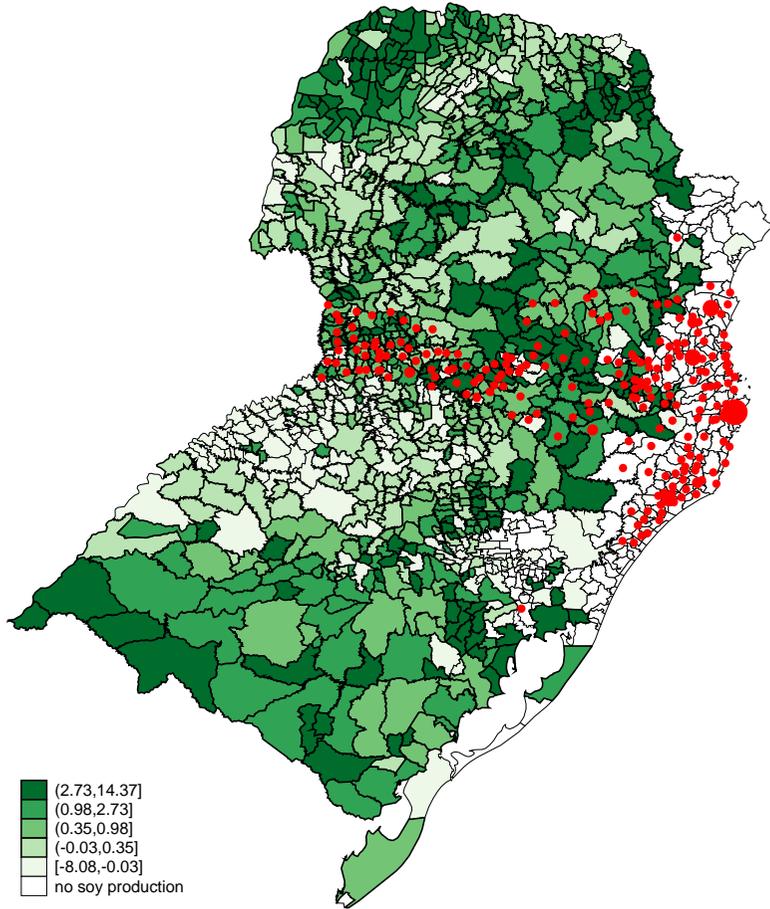


FIGURE VI: Potential soy yield under high agricultural technology

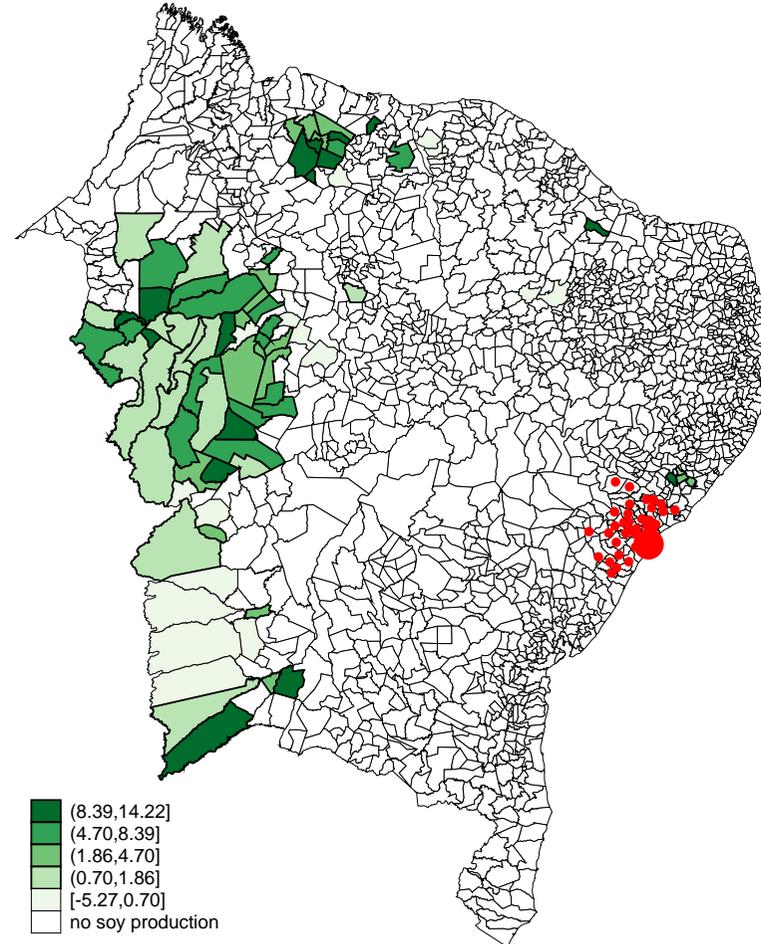
Notes: Data from FAO-GAEZ.

FIGURE VII: BANK NETWORKS AND INCREASE IN SOY REVENUES

(a) Bank A

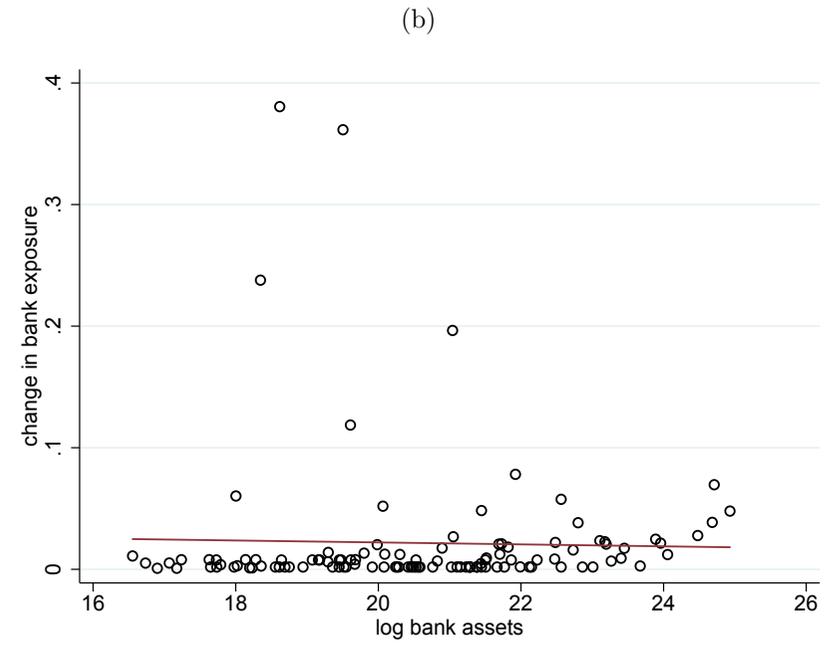
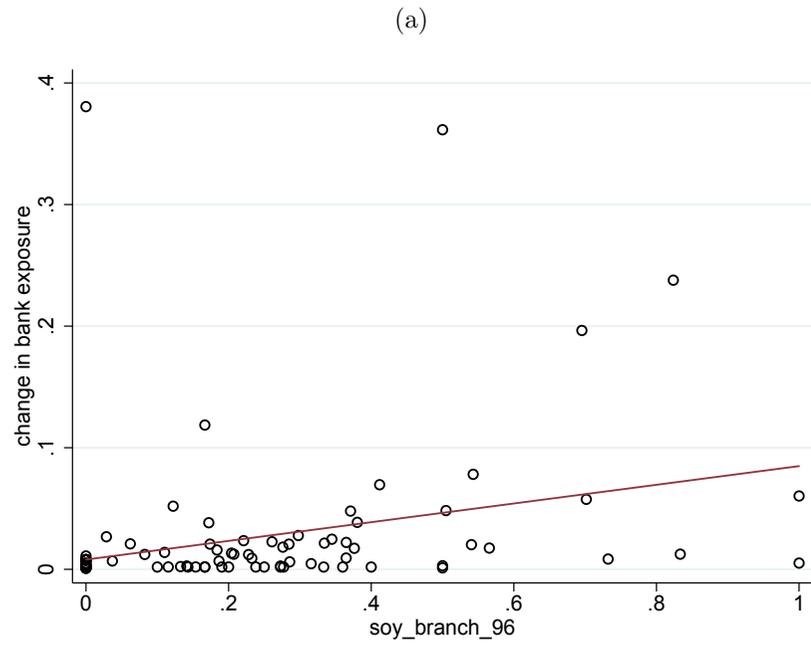


(b) Bank B



Notes: Data from Central Bank of Brazil and PAM (IBGE).

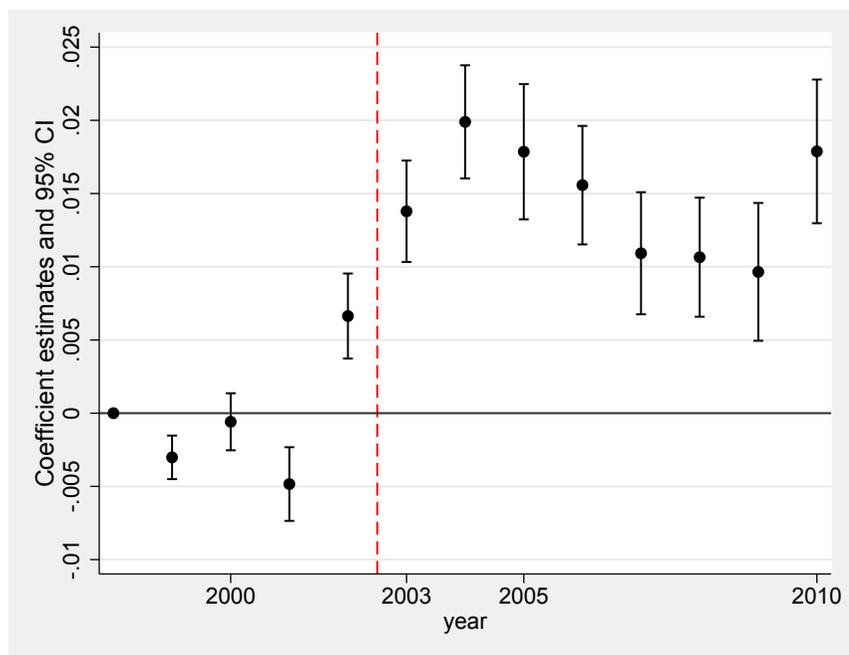
FIGURE VIII: CHANGE IN BANK EXPOSURE AND BANK CHARACTERISTICS



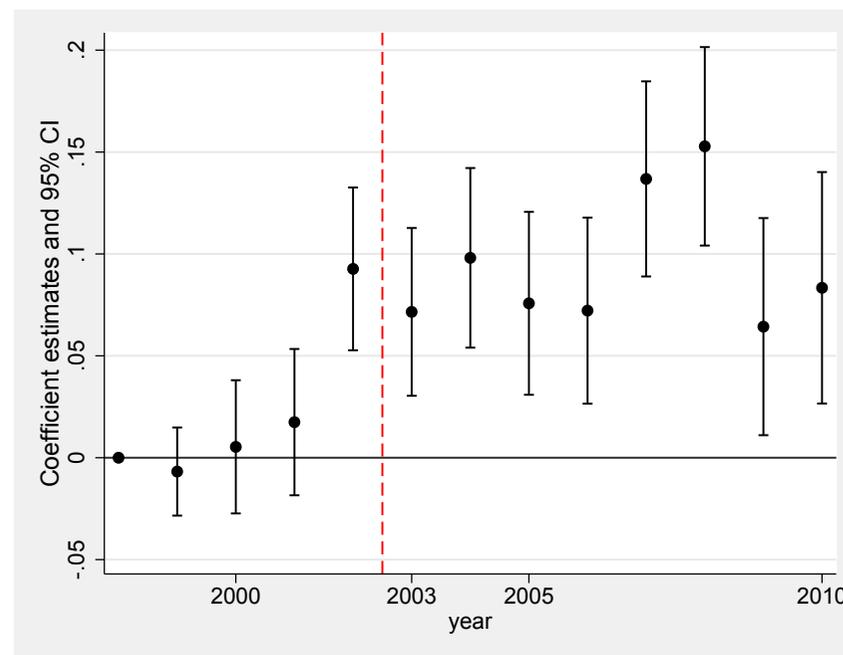
Notes: Panel (a): estimated slope -0.0008 (t-stat = -0.30); Panel (b): estimated slope $.0769$ (t-stat= 3.52)

FIGURE IX: INCREASE IN POTENTIAL SOY YIELD AND TIMING OF SOY EXPANSION AND BANK DEPOSITS

(a) Soy Expansion



(b) Bank Deposits



Notes: Data from Central Bank of Brazil and PAM (IBGE).

TABLE I: SUMMARY STATISTICS

variable name	mean	median	st.dev.	N obs
independent variables:				
$\log(A_{jt}^{soy})$	-0.289	-0.417	1.137	44,524
$\Delta \log(A_{jt}^{soy})$	1.917	1.887	0.466	3,020
bank exposure	0.003	0.011	0.022	1,549,127
destination municipality exposure	10.638	10.712	1.350	22,273
bank branch exposure	-0.022	-0.002	0.172	139,433
outcome variables at municipality level:				
$\Delta \frac{GESoyArea}{AgriArea}$	0.015	0.000	0.064	3,020
$\Delta \frac{Non-GESoyArea}{AgriArea}$	-0.003	0.000	0.055	3,020
Δ Agri Profits per he (%)	0.319	-0.094	1.867	3,020
Δ Agri Investment per he (%)	0.475	0.183	1.042	3,020
$\frac{SoyArea}{AgriArea}$	0.052	0.000	0.136	44,524
$\log(1 + \text{revenues from soy production})$	5.104	0.000	6.958	44,524
$\log(\text{total deposits})$	15.688	15.582	1.811	44,524
$\log(\text{total loans})$	15.452	15.637	2.114	44,524
I_{dt} : share of firms with access to bank credit	0.054	0.045	0.055	23,660
outcome variables at bank-branch level:				
$\log(\text{total deposits})$	15.243	15.264	1.595	139,433
$\log(\text{total loans})$	15.087	15.107	1.732	139,433
dep - loans / liabilities	0.081	0.097	0.496	139,433
outcome variables at firm level:				
\log loan - main lender	10.320	10.310	1.667	1,549,127
\log loan - all lenders	10.803	10.757	1.845	1,549,127
\log employment	2.025	1.922	1.456	1,549,127
\log wage bill	8.317	8.191	1.704	1,549,127

Notes: See section III for detailed description of each variable and data sources.

TABLE II: SOY TECHNICAL CHANGE AND AGRICULTURAL OUTCOMES
 GE SOY ADOPTION, AGRICULTURAL PROFITS AND INVESTMENT PER HECTARE

Dependent variables:	$\frac{\text{GE Soy Area}}{\text{Agricultural Area}}$		$\frac{\text{Non-GE Soy Area}}{\text{Agricultural Area}}$		Δ Profits per he (%)		Δ Investment per he (%)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \log A^{\text{soy}}$	0.036*** [0.003]	0.033*** [0.003]	-0.014*** [0.003]	-0.016*** [0.003]	0.248*** [0.070]	0.229*** [0.079]	0.141*** [0.043]	0.214*** [0.048]
municipality controls		yes		yes		yes		yes
Observations	3,020	3,020	3,020	3,020	3,020	3,020	3,020	3,020
R-squared	0.070	0.152	0.014	0.044	0.004	0.014	0.004	0.018

Notes: Robust standard errors reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census).

TABLE III: SOY TECHNICAL CHANGE AND AGRICULTURAL OUTCOMES
 SHARE OF SOY HARVESTED AREA, REVENUES FROM SOY PRODUCTION

Dependent variables:	$\frac{\text{Soy Area}_t}{\text{Agri Area}_{t=1996}}$		$\frac{\text{Soy Value}_t}{\text{Agri Area}_{t=1996}}$		$\log(1 + \text{Soy Value}_t)$	
	(1)	(2)	(3)	(4)	(5)	(6)
$\log A^{\text{soy}}$	0.017*** [0.002]	0.014*** [0.002]	24.387*** [1.791]	21.459*** [1.786]	0.557*** [0.081]	0.181** [0.087]
municipality controls \times year fe		yes		yes		yes
Observations	44,524	44,524	44,524	44,524	44,524	44,524
R-squared	0.958	0.959	0.889	0.894	0.891	0.894
N clusters	3177	3177	3177	3177	3177	3177

Notes: Standard errors clustered at municipality level are reported in brackets. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Soy revenues are monetary value in 2000 BRL at municipality/year level, in logs, winsorized at 1% in each tail. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census).

TABLE IV: SOY TECHNICAL CHANGE AND LOCAL BANKING SECTOR OUTCOMES
TOTAL DEPOSITS AND TOTAL LENDING

Dependent variables:	log(deposits)		log(loans)	
	(1)	(2)	(3)	(4)
$\log A^{soy}$	0.025* [0.014]	0.061*** [0.015]	-0.087*** [0.027]	-0.056** [0.028]
municipality controls \times year fe		yes		yes
Observations	44,524	44,524	44,524	44,524
R-squared	0.975	0.976	0.950	0.952
N clusters	3177	3177	3177	3177

Notes: Outcomes are total monetary value (in 2000 BRL) at municipality/year level, in logs, winsorized at 1% in each tail. Standard errors clustered at municipality level are reported in brackets. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census).

TABLE V: BANK EXPOSURE TO SOY TECHNICAL CHANGE
DEPOSITS, LOANS AND CAPITAL EXPORT AT BRANCH-LEVEL

Dependent variables:	log(deposits)	log(loans)	(deposits - loans)/ liabilities
	(1)	(2)	(3)
$\log A^{soy} \times T$	0.489*** [0.178]	0.093 [0.117]	0.065*** [0.015]
Observations	139,433	139,433	139,433
R-squared	0.617	0.715	0.566
N clusters	3397	3397	3397

Notes: Regressions are weighted by total deposits at bank level in 1996 divided by number of municipalities where a bank has branches at any point in time. Outcomes are total monetary value (in 2000 BRL) at municipality/bank/year level, in logs, winsorized at 1% in each tail. Standard errors clustered at municipality level are reported in brackets. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

TABLE VI: THE EFFECT OF BANK EXPOSURE ON FIRM-LEVEL OUTCOMES
LOANS, EMPLOYMENT, WAGE BILL

Dependent variables:	log loan main lender		log loan all lenders		log employment		log wage bill	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>BankExposure</i>	6.408 [1.844]***	6.338 [1.797]***	-0.961 [1.525]	-1.047 [1.538]	0.582 [0.202]***	0.531 [0.185]***	0.900 [0.234]***	0.792 [0.223]***
fixed effects:								
firm	y	y	y	y	y	y	y	y
year	y	y	y	y	y	y	y	y
Municipality × year	y	y	y	y	y	y	y	y
2-digit Sector × year		y		y		y		y
Observations	1,549,128	1,549,127	1,549,128	1,549,127	1,549,128	1,549,127	1,549,128	1,549,127
R-squared	0.670	0.671	0.755	0.756	0.894	0.894	0.911	0.911
N clusters	115	115	115	115	115	115	115	115

Notes: Standard errors clustered at main lender level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

TABLE VII: THE EFFECT OF BANK EXPOSURE ON FIRM-LEVEL OUTCOMES - BY NUMBER OF LENDING RELATIONSHIPS
LOANS, EMPLOYMENT, WAGE BILL

Dependent variables:	SINGLE LENDER				MULTIPLE LENDERS			
	log loan main lender	log loan all lenders	log employment	log wage bill	log loan main lender	log loan all lenders	log employment	log wage bill
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>BankExposure</i>	4.613 [1.864]**	4.618 [1.862]**	2.060 [0.417]***	2.208 [0.461]***	6.716 [1.828]***	-1.472 [1.564]	0.431 [0.200]**	0.698 [0.238]***
fixed effects:								
firm	y	y	y	y	y	y	y	y
year	y	y	y	y	y	y	y	y
Municipality × year	y	y	y	y	y	y	y	y
2-digit Sector × year	y	y	y	y	y	y	y	y
Observations	351,509	351,509	351,509	351,509	1,188,965	1,188,965	1,188,965	1,188,965
R-squared	0.622	0.623	0.870	0.891	0.654	0.736	0.892	0.908
N clusters	96	96	96	96	115	115	115	115

Notes: Standard errors clustered at main lender level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

TABLE VIII: THE EFFECT OF BANK EXPOSURE ON FIRM-LEVEL OUTCOMES - BY SECTOR
LOANS, EMPLOYMENT, WAGE BILL

indep var: <i>BankExposure</i>	log loan main lender (1)	log loan all lenders (2)	log employment (3)	log wage bill (4)
Agriculture	8.828 [2.563]***	2.566 [2.797]	1.294 [1.229]	1.100 [1.153]
Observations	5,410	5,410	5,410	5,410
R-squared	0.858	0.880	0.941	0.948
N clusters	53	53	53	53
Manufacturing	8.681 [2.108]***	0.071 [1.801]	0.404 [0.231]*	0.652 [0.292]**
Observations	268,621	268,621	268,621	268,621
R-squared	0.702	0.790	0.899	0.919
N clusters	101	101	101	101
Services	5.653 [1.710]***	-1.436 [1.466]	0.574 [0.199]***	0.808 [0.232]***
Observations	1,183,207	1,183,207	1,183,207	1,183,207
R-squared	0.658	0.743	0.884	0.901
N clusters	111	111	111	111
Other	6.438 [2.353]***	0.084 [2.001]	0.258 [0.505]	0.749 [0.600]
Observations	74,200	74,200	74,200	74,200
R-squared	0.720	0.792	0.946	0.953
N clusters	76	76	76	76
fixed effects in all specifications				
firm	y	y	y	y
year	y	y	y	y
AMC × year	y	y	y	y
Sector (2d CNAE) × year	y	y	y	y

Notes: Standard errors clustered at main lender level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

TABLE IX: THE EFFECT OF BANK EXPOSURE ON FIRM-LEVEL OUTCOMES - BY SECTOR AND NUMBER OF LENDING RELATIONSHIPS

indep var: <i>BankExposure</i>	SINGLE LENDER				MULTIPLE LENDERS			
	log loan main lender (1)	log loan all lenders (2)	log employment (3)	log wage bill (4)	log loan main lender (5)	log loan all lenders (6)	log employment (7)	log wage bill (8)
Agriculture	11.879 [8.725]	12.006 [8.844]	1.706 [3.098]	1.958 [2.247]	8.221 [2.386]***	-1.040 [2.532]	1.060 [1.512]	0.535 [1.426]
Observations	1,073	1,073	1,073	1,073	3,407	3,407	3,407	3,407
R-squared	0.895	0.897	0.941	0.945	0.851	0.870	0.943	0.950
N clusters	24	24	24	24	47	47	47	47
Manufacturing	6.694 [2.511]**	6.692 [2.509]**	1.877 [0.585]***	1.992 [0.565]***	8.856 [2.092]***	-0.457 [1.865]	0.347 [0.277]	0.608 [0.340]*
Observations	44,568	44,568	44,568	44,568	220,700	220,700	220,700	220,700
R-squared	0.653	0.654	0.877	0.898	0.686	0.772	0.896	0.915
N clusters	55	55	55	55	100	100	100	100
Services	4.064 [1.734]**	4.069 [1.732]**	2.091 [0.410]***	2.219 [0.455]***	6.029 [1.756]***	-1.865 [1.501]	0.460 [0.216]**	0.700 [0.250]***
Observations	277,355	277,355	277,355	277,355	898,424	898,424	898,424	898,424
R-squared	0.619	0.621	0.856	0.881	0.640	0.721	0.883	0.899
N clusters	91	91	91	91	111	111	111	111
Other	3.482 [2.632]	3.452 [2.632]	1.508 [0.507]***	1.708 [0.634]***	7.056 [2.391]***	0.242 [1.822]	0.220 [0.488]	0.727 [0.574]
Observations	18,883	18,883	18,883	18,883	53,117	53,117	53,117	53,117
R-squared	0.678	0.679	0.944	0.951	0.714	0.784	0.944	0.950
N clusters	53	53	53	53	68	68	68	68
fixed effects								
firm	y	y	y	y	y	y	y	y
year	y	y	y	y	y	y	y	y
AMC × year	y	y	y	y	y	y	y	y
Sector (2d CNAE) × year	y	y	y	y	y	y	y	y

Notes: Standard errors clustered at main lender level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

TABLE X: PROPAGATION TO NON-SOY PRODUCING REGIONS: ACCESS TO BANK CREDIT
OVERALL, BY SECTOR AND FIRM SIZE CATEGORY

	sector					firm size category			
	all firms (1)	agriculture (2)	manufacturing (3)	services (4)	other (5)	micro (6)	small (7)	medium (8)	large (9)
<i>MunicipalityExposure</i>	0.015 [0.005]***	0.011 [0.018]	0.020 [0.011]*	0.011 [0.004]**	0.003 [0.009]	0.017 [0.005]***	0.029 [0.014]**	0.041 [0.033]	-0.008 [0.020]
fixed effects:									
municipality	yes	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes	yes
municipality controls x year	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	23,660	14,559	18,803	23,447	23,440	23,550	20,470	12,543	22,040
R-squared	0.501	0.446	0.513	0.482	0.278	0.394	0.433	0.487	0.573
N clusters	1696	1458	1574	1695	1696	1696	1664	1404	1694

Notes: Outcomes winsorized at 1% in each tail. Standard errors clustered at municipality level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

VII APPENDIX

TABLE XI: POTENTIAL SOY PROFITABILITY AND LOCAL DEPOSITS
ADDITIONAL RESULTS

VARIABLES	(1) log(demand and saving dep.)	(2) log(term deposits)	(3) log(demand and saving dep.)	(4) log(demand and saving dep.)
log A^{soy}	0.055*** [0.014]	0.153 [0.102]	0.037*** [0.014]	0.054*** [0.014]
log $A^{soy} \times$ South			0.053*** [0.009]	
log $A^{soy} \times$ Center-West				0.004 [0.010]
Observations	44,524	44,524	44,524	44,524
R-squared	0.977	0.850	0.977	0.977
N clusters	3177	3177	3177	3177

Notes: Outcomes are total monetary value (in 2000 BRL) at AMC/year level, in logs, winsorized at 1% in each tail. Standard errors clustered at AMC level are reported in brackets. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Controls include municipality initial characteristics interacted with year fixed effects. Municipality characteristics include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, as well as characteristics of the local banking sector.

TABLE XII: POTENTIAL SOY
PROFITABILITY AND LOCAL BANKING
SECTOR OUTCOMES
DEPOSITS - IV COEFFICIENTS

VARIABLES	(1) log(deposits)	(2) log(deposits)
Soy Area Share	4.352*** [1.097]	
log(1 + <i>SoyValue</i>)		0.337* [0.180]
Observations	44,510	44,510
R-squared	0.658	-1.457
Number of AMC	3,163	3,163

Notes: Outcomes are total monetary value (in 2000 BRL) at AMC/year level, in logs, winsorized at 1% in each tail. Standard errors clustered at AMC level are reported in brackets. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Controls include municipality initial characteristics interacted with year fixed effects. Municipality characteristics include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate.