Capital Accumulation and Structural Transformation*

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Abstract

Several scholars argue that high agricultural productivity growth can retard industrial development as it draws resources towards the comparative advantage sector, agriculture. However, agricultural productivity growth can lead to industrialization through its impact on capital accumulation. We highlight this effect in a simple model where larger agricultural profits increase the supply of capital, generating an expansion of the capital-intensive sector, manufacturing. To test the predictions of the model we exploit a large and exogenous increase in agricultural profits due to the adoption of genetically engineered soy in Brazil. We find that profits generated in soy-producing regions were not reinvested locally. Instead, agricultural productivity growth generated capital outflows from rural areas. To trace the destination of capital flows we match data on deposit and lending activity of all bank branches in Brazil, bank-firm credit relationships and firm employment. We find that capital reallocated from soy-producing to non-soy producing regions, and from agriculture to non-agricultural activities. The degree of financial integration affects the speed of structural transformation. First, regions that are more financially integrated with soy-producing areas experienced faster growth in non-agricultural lending. Second, firms that are better connected to soy-producing areas through their pre-existing banking relationships experienced larger growth in borrowing and employment.

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I Introduction

The process of economic development is characterized by a reallocation of production factors from the agricultural to the industrial and service sectors. Economic historians have argued that in the first industrialized countries technical improvements in agriculture favored this process by increasing demand for manufactures or generating savings to finance industrial projects.[1] However, the recent experience of some low-income countries appears inconsistent with the idea that high agricultural productivity leads to economic development. The theoretical literature has proposed two sets of explanations. First, the positive effects of agricultural productivity on economic development might not take place in open economies where manufactures can be imported and savings can be exported.[2] Second, market frictions might constrain factor reallocation.[3] The recent empirical literature has focused on understanding how these mechanisms shape the process of labor reallocation.[4] However, there is scarce direct empirical evidence on the process of capital reallocation from the rural agricultural sector to the urban industrial sector.[5]

In this paper we study the effects of productivity growth in agriculture on the allocation of capital across sectors. To guide the empirical analysis we refer to the Heckscher-Ohlin model which illustrates the classic effect of agricultural technical change on structural transformation in an open economy: larger agricultural productivity increases the demand for capital in agriculture, thus capital reallocates towards this sector (Findlay and Grubert 1959). This is the negative effect of agricultural comparative advantage on industrialization highlighted in the development literature and we refer to it as the capital demand effect. In this paper, we present a simple two-period version of the model where larger agricultural income generates savings, the supply of capital increases and thus the capital-intensive sector, manufacturing, expands. This positive effect of agricultural productivity on industrialization has been overlooked by the literature and will be the main focus of our empirical analysis. We refer to it as the capital supply effect.

Our empirical analysis attempts to trace the causal effects of agricultural productivity growth on the allocation of capital across sectors and regions. This has proven challenging

[1]See, for example, Crafts (1985) and Crouzet (1972). See also Rosenstein-Rodan (1943), Nurkse (1953), Rostow (1960).

[2]Corden and Neary (1982), Matsuyama (1992).

[3]Banerjee and Newman (1993), Murphy, Shleifer, and Vishny (1989), Galor and Zeira (1993), Acemoglu and Zilibotti (1997). See also the recent macroeconomic literature on financial frictions and development: Giné and Townsend (2004), Jeong and Townsend (2008), Buera, Kaboski, and Shin (2015), Moll (2014).

[4]For labor reallocation across sectors see: Herrendorf, Rogerson, and Valentinyi (2013), McCaig and Pavcnik (2013), Foster and Rosenzweig (2004, 2007), Bustos, Caprettini, and Ponticelli (2016). For labor reallocation across regions see: Bryan and Morten (2015), Moretti (2011), Munshi and Rosenzweig (2016). For labor reallocation across sectors and regions see: Michaels, Rauch, and Redding (2012), Fajgelbaum and Redding (2014).

[5]A notable exception is Banerjee and Munshi (2004) who document larger access to capital for entrepreneurs belonging to rich agricultural communities in the garment industry in Tirupur, India.

for the literature due to the limited availability of data on capital flows within countries. We overcome this difficulty by using detailed information on deposits and loans for each bank branch in Brazil. We match this data with confidential information on bank-firm credit relationships and social security records containing the employment histories for the universe of formal firms. Therefore, our final dataset permits to observe capital flows across both sectoral and spatial dimensions. We use this data to establish the causal effect of agricultural productivity growth on the direction of capital flows. For this purpose, we exploit a large and exogenous increase in agricultural productivity: namely the legalization of genetically engineered (GE) soy in Brazil. This new technology had heterogeneous effects on yields across areas with different soil and weather characteristics, which permits to estimate the local effects of agricultural productivity growth. However, because soy producing regions tend to be rural, capital reallocation towards the urban industrial sector needs to take place across regions. Thus, a second step in our empirical strategy relies on differences in the degree of financial integration across regions to trace capital flows from rural to urban areas.

First, we study the local effects of agricultural productivity growth. We find that municipalities subject to faster exogenous technical change indeed experienced faster adoption of GE soy and growth in agricultural profits. We think of these municipalities directly affected by agricultural technical change as *origin* municipalities. Consistent with the model, we find that these municipalities experienced a larger increase in saving deposits in local bank branches. However, there was no increase in local bank lending. As a result, agricultural technical change generated capital outflows from origin municipalities. This finding suggests that the increase in the local demand for capital is smaller than the increase in savings. Thus, banks must have reallocated savings towards other regions. Therefore, we propose a methodology to track the destination of those savings generated by agricultural productivity growth.

In a second step of the analysis, we need to trace the reallocation of capital across space. 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 *origin* municipalities to *destination* municipalities. First, we show that banks more exposed to the soy boom through their branch network indeed had a larger increase in aggregate deposits. Next, we track the destination of those deposits generated by agricultural technical change. For this purpose, we assume that, due to imperfections in the interbank market, banks are likely to fund part of their loans with their own deposits. This implies that we can construct exogenous credit supply shocks across destination municipalities using differences in the geographical structure of bank branch networks. We use this variation to assess whether destination municipalities more connected to origin municipalities experiencing agricultural productivity growth received larger capital inflows. We find that municipalities with relatively larger presence of banks receiving funds from the soy boom experienced faster increases in credit supply. Interestingly, these funds went entirely to non-soy producing regions and were channeled to non-agricultural activities.

The findings discussed above are consistent with the capital supply mechanism emphasized by the model: agricultural technical change can increase savings and lead to a reallocation of capital towards the capital intensive sector, manufacturing. Our empirical analysis permits to quantify this effect by comparing the speed of capital reallocation across sectors in non-soy producing municipalities with different degrees of financial integration with the soy boom area. During the period under study (1996-2010), the share of non-agricultural lending increased from 75 to 84 percent in the average non-soy producing municipality. However, the degree of capital reallocation away from agriculture varied extensively across municipalities: the interquartile range was 23 percentage points. Our estimates imply that the differences in the degree of financial integration with the soy boom area can explain 15 percent of the observed differences in the increase in non-agricultural lending share across non-soy producing municipalities.

As mentioned above, our findings are consistent with the capital supply mechanism emphasized by the model. However, to the extent that destination municipalities which are more connected to origin municipalities through bank-branch networks are also more connected through the transportation or commercial networks, it is possible that our estimates are capturing the effects of agricultural technical change through other channels. For example, if technical change is labor-saving, former agricultural workers might migrate towards cities increasing labor supply, the marginal product of capital and capital demand. Similarly, cities could face larger product demand from richer farmers. As a result, our empirical strategy permits to assess the effect of agricultural productivity on the allocation of capital across sectors but can not isolate whether this occurs through a labor supply, product demand or capital supply channel. To make progress on this front we need to implement a firm-level empirical strategy which permits to control for labor supply and product demand shocks in destination municipalities, which we describe below.

In a third step of the analysis, we trace the reallocation of capital towards firms located in destination municipalities. For this purpose, we match 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 use these shocks to assess whether firms whose pre-existing lenders are more connected to soy-producing regions through bank branch networks experienced larger increases in borrowing and employment growth. This empirical strategy permits to isolate the capital supply channel by comparing firms borrowing from different banks but operating in the same municipality and sector, thus subject to the same labor supply and product demand shocks.

We find that firms with pre-existing relationships more exposed banks experienced a larger increase in borrowing from those banks. Interestingly, we find similar point estimates when we control for municipality and sector-level shocks. This suggests that the increase in firm borrowing is driven by the capital supply effect of agricultural technical change and not the labor supply or product demand effects. We can use our estimates to calculate the elasticity of firm loans to bank deposits due to the soy shock: a 1 percent increase in bank deposits in origin municipalities generated a 0.19 percent increase in loans to firms operating in non-soy producing municipalities. Consistent with the aggregate results described above, we find that most of the new capital was allocated to non-agricultural firms: out of each 1 R$ of new loans in destination municipalities from the soy-driven deposit shock, 0.5 cents were allocated to firms in agriculture, 40 cents to firms in manufacturing, 48 cents to firms in services and 12 cents to other sectors.

Next, we try to assess whether larger loans led to firm growth, which we measure in terms of employment and wage bill. We find that firms whose pre-existing lenders have a larger exposure to the soy boom experienced larger growth in employment and wage bill. In contrast with the loan estimates discussed above, we find that our estimated real effects fall to almost half when we control for municipality and sector-level shocks. This finding indicates that municipalities more connected through bank branch networks might also be more connected through transportation or commercial networks, thus are more likely to receive not only capital supply shocks but also labor supply or product demand shocks due to agricultural productivity growth. As a result, firm-loan-level data is necessary to separately identify the effects of the capital supply channel on the allocation of labor across sectors. Our estimated coefficients indicate that out of 100 additional workers in destination municipalities due to the soy-driven capital supply increase, 2 were employed in agriculture, 32 in manufacturing, 62 in services and 4 in other sectors.

Taken together, our empirical findings imply that agricultural productivity growth can lead to structural transformation in open economies through its impact on capital accumulation. The size of this effect depends on several features of the environment. First, the relative strength of the demand and supply effects of agricultural technical change, which work in opposite directions. The finding that the adoption of new agricultural technologies generates more profits than investment suggests that the supply effect dominates. In this case, the model predicts that capital reallocates towards non-agricultural sectors. Because soy producing regions tend to be rural, this reallocation needs to take place both across sectors and regions. Indeed, we observe capital outflows from soy producing regions. Thus, a second key feature of the environment is the degree of financial integration across rural and urban areas. We find that regions more connected with the soy boom area through bank branch networks experience faster structural transformation.

Related Literature

Our paper is related to a large literature characterizing the development process as one where agricultural workers migrate to cities to find employment in the industrial and service sectors. Understanding the forces behind this reallocation process is important, especially when labor productivity is lower in agriculture than in the rest of the economy (Gollin, Lagakos, and Waugh 2014). There is a rich recent empirical literature analyzing the determinants of the reallocation of labor both across sectors (Herrendorf et al. 2013, McCaig and Pavcnik 2013, Foster and Rosenzweig 2004, 2007, Bustos et al. 2016), and across regions (Michaels et al. 2012, Fajgelbaum and Redding 2014, Moretti 2011, Bryan and Morten 2015, Munshi and Rosenzweig 2016). In contrast, our knowledge of the process of capital reallocation is extremely limited.[6]

The scarcity of empirical studies on the reallocation of capital is often due to the limited availability of data on the spatial dimension of capital movements.[7] In this paper, we are able to track internal capital flows across regions in Brazil using detailed data on deposit and lending activity at branch level for all commercial banks operating in the country. This data permits to obtain a measure of municipality-level capital flows by computing the difference between deposits and loans originated in the same location. To the best of our knowledge, this is the first dataset which permits to observe capital flows across regions within a country for the entire formal banking sector.

A second challenge we face is to sign the direction of capital flows: from the agricultural rural sector to the urban industrial sector. We proceed in two steps. First, we exploit differences in the potential benefits of adopting GE soy across regions in Brazil to find the causal effects of agricultural technical change in local capital markets. This empirical strategy was first used in Bustos et al. (2016) to study the effect of agricultural technical change in local labor markets. However, the large capital mobility across regions found in the data requires a different empirical strategy which permits to track capital flows from origin to destination municipalities. Thus, we propose a new strategy which exploits differences in the geographical structure of bank branch networks to measure differences in the degree of financial integration of origin and destination municipalities. This strategy builds on the insights of the literature studying the effects of transportation networks on goods market integration such as Donaldson (2015) and Donaldson and Hornbeck (2016).

A third challenge is to isolate the capital supply channel from other effects of agricultural technical change which could spill over to connected regions. We overcome this difficulty by bringing the analysis to the firm level. This allows us to construct firm-

[6]See Crafts (1985) and Crouzet (1972) for early studies on the role of agriculture as a source of capital for other sectors during the industrial revolution in England. See also contemporaneous work by Marden (2016) studying the local effects of agricultural productivity growth in China, and Moll, Townsend, and Zhorin (2017), that propose a model on labor and capital flows between rural and urban regions, and calibrate it using data on Thailand.

[7]For a detailed discussion of the literature which points out this limitation, see Foster and Rosenzweig (2007).

level credit supply shocks by exploiting differences in the geographical structure of the branch network of their lenders. Our paper is thus related to two strands of the literature studying the effect of exogenous credit supply shocks. First, the development literature studying the effects of exogenous credit shocks on firm growth (Banerjee and Duflo 2014, Cole 2009, McKenzie and Woodruff 2008, De Mel, McKenzie, and Woodruff 2008, Banerjee, Karlan, and Zinman 2001, Banerjee, Duflo, Glennerster, and Kinnan 2013). Second, the finance literature studying the effects of bank liquidity shocks. This literature has established that bank credit supply changes can have important effects on lending to firms and employment (Chodorow-Reich 2014, Khwaja and Mian 2008) as well as on loans to individuals such as mortgages (Gilje, Loutskina, and Strahan 2013). We contribute to this literature by proposing a methodology to trace the reallocation of capital from the rural agricultural sector to the urban industrial and service sectors. To the best of our knowledge, this is the first study to undertake this task.

Our model builds on dynamic versions of the Hecksher-Ohlin model studied by Stiglitz (1970), Findlay (1970) and Ventura (1997). With respect to previous literature, we emphasize how an increase in agricultural productivity can have opposite effects on capital allocation across sectors. The demand effect generates a reallocation of capital and labor towards agriculture, the comparative advantage sector.[8] The supply effect, instead, generates a reallocation of both factors towards the capital-intensive sector, manufacturing. This is the well-known Rybzcinsky theorem (Rybczynski, 1955).[9] Therefore, the net effect of agricultural technical change will depend on the relative strength of the demand and the supply effects, an aspect overlooked by the previous literature.

The rest of the paper is organized as follows. We start by presenting a simple model to illustrate the effects of agricultural technical change on structural transformation in open economies in section II. Then, in section III, we provide background information on the introduction of genetically engineered soy seeds in Brazil and its impact on agricultural profitability. Section IV describes the data used in the empirical analysis. In section V we present the identification strategy and discuss the empirical results of the paper. Finally, section VI concludes.

II Theoretical Framework

In this section we present a simple two-period and two-sector neoclassical model to illustrate the effects of agricultural technical change on structural transformation in open

[8]These effects have been emphasized by the theoretical literature linking larger agricultural productivity to de-industrialization (Corden and Neary 1982 and Matsuyama 1992).

[9]Notice that this prediction only applies when goods are traded. In a closed economy, an increase in the supply of capital would generate faster output growth in the capital intensive-sector, a reduction in its price and a reallocation of capital towards non-capital intensive sectors, as emphasized by Acemoglu and Guerrieri (2008).

economies. The model is a simplified version of the dynamic Hecksher-Ohlin models studied by Stiglitz (1970), Findlay (1970) and Ventura (1997).

II.A Setup

Consider a small open economy where there is one final good which can be used for consumption and investment. In addition, there are two intermediate goods used in the production of the final good. The first intermediate is a manufacturing good and the second is an agricultural good. The final good is non-traded while the two intermediate goods are freely traded. Finally, there are two production factors, land and capital.

Production
There is a perfectly competitive final goods sector with the following CES production technology:

$$Q_f = [Q_a^{\rho} + Q_m^{\rho}]^{\frac{1}{\rho}} \tag{1}$$

where $\rho < 1$, Q_f denotes production of the final good, Q_a denotes purchases of the agricultural intermediate good and Q_m denotes purchases of the manufactured intermediate good. The parameter $\sigma = (1-\rho)^{-1}$ captures the elasticity of substitution between the two inputs.

There are constant returns to scale in both intermediate goods sectors, which are also perfectly competitive. Production of the manufactured good requires only capital while production of the agricultural good requires only land. As a result, $Q_m = K_m$, where Q_m denotes production of the manufactured good, and K_m denotes capital allocated to the manufacturing sector. Similarly, production of the agricultural good requires only land, thus $Q_a = A_a T_a$, where Q_a denotes production of the agricultural good, A_a is agricultural productivity and T_a is land allocated to the agricultural sector. This extreme version of technology is used to simplify the model, following Ventura (1997) who shows that the main predictions of his model also hold when both sectors use both factors.

Preferences
Individuals in this economy only live for two periods, thus their utility function is:

$$U(C_1, C_2) = lnC_1 + \beta lnC_2 \tag{2}$$

an the budget constraint of a representative individual is:

$$C_1 + I_1 \quad = \quad r_{K,1}K_1 + r_{T,1}T \tag{3}$$

$$C_2 = r_{K,2}K_2 + r_{T,2}T$$

$$K_2 = K_1 + I_1$$

where T is the land endowment and K_t is the capital endowment in each period $t = 1, 2$, I_1 is investment and C_t is consumption in each period $t = 1, 2$.

II.B Equilibrium

The representative firm in the final goods sector minimizes production costs given demand for the final good, which must equal income, thus intermediate good demands are:

$$Q_a = P_a^{-\sigma} (r_K K + r_T T)$$

$$Q_m = P_m^{-\sigma} (r_K K + r_T T),$$

where we omit time subindexes for simplicity. Note that because the final goods sector is competitive, the price of the final good must equal unit production costs. Because the final good is the numeraire, this implies:

$$P_a^{\frac{\rho}{\rho-1}} + P_m^{\frac{\rho}{\rho-1}} = 1.$$

Thus, even if the final good is non-traded, its price is given by the international prices of traded intermediates.

Finally, free trade and perfect competition in the intermediate goods sectors imply that prices equal average (and marginal) production costs in each sector:

$$P_a = \frac{1}{A_a} r_T \tag{4}$$

$$P_m = r_{K.} \tag{5}$$

Full employment of factors is ensured by employing all capital in manufacturing and all land in agriculture. Thus, output in each sector is:

$$Q_a = A_a T$$

$$Q_m = K.$$

As mentioned above, we consider a small open economy taking intermediate goods prices as given. The derivations above show that in this setup conditional factor prize equalization always hold, thus the rental price of capital and land rents are only determined by international factor prices and technology. Thus, because we are interested in a situation where international prices and home technology are constant over time, in what follows we consider an equilibrium where home factor prices are constant over time.

The representative consumer chooses C_1, C_2 and I_1 to maximize (2) subject to (3). The first order conditions of this problem are:

$$\frac{C_2}{C_1} = \beta r_K$$

$$K_2 = (1 + r_K) K_1 + r_T T - C_1$$

$$C_2 = r_K K_2 + r_T T$$

Substituting equilibrium factor prices in the FOC we can solve for K_2 , C_2 and C_1, as follows:

$$K_2 = \frac{\beta}{1+\beta} \left\{ (1 + P_m) K_1 + A_a P_a T \left[\frac{P_m \beta - 1}{P_m \beta} \right] \right\} \tag{6}$$

$$C_2 = P_m K_2 + A_a P_a T$$

$$C_1 = \frac{C_2}{P_m \beta}$$

II.C Agricultural Productivity Growth

In this section we discuss the effects of a permanent increase in agricultural productivity. That is, we compare the equilibrium level of sectoral outputs in two economies, one of which has larger agricultural productivity in both periods.

Static effect:
Agricultural output and land rents increase in the same proportion as agricultural productivity (A_a). This is because agricultural production uses only land ($Q_a = A_a T_a$) and land is used only in agriculture, thus land market clearing implies $Q_a = A_a T$. In turn, the zero profit condition for agriculture (equation 4) implies that because P_a is determined in world markets, an increase in A_a generates a proportional increase in land rents. Note that, due to the extreme version of technology assumed, manufacturing production is not affected by the increase in agricultural productivity. However, in a standard Heckscher-Ohlin model where both sectors use both factors, a Hicks-neutral increase in agricultural productivity would generate a reallocation of land and capital towards agriculture and

a contraction of the manufacturing sector (Findlay and Grubert 1959). We refer to this increase in the demand for capital from the agricultural sector as the capital demand effect.

Dynamic effect:
An increase in agricultural productivity leads to higher income and savings, a larger capital stock and growth in manufacturing output. This is because an increase in A_a generates growth in K_2 as long as $P_m\beta>1$ (See equation 6). Note that the increase in agricultural productivity is a permanent income shock, thus it generates savings only if consumption is growing over time ($C_2 > C_1$), which occurs when the interest rate ($r_k = P_m$) is larger than the discount rate ($\frac{1}{\beta}$).[10]

Finally, the increase in the capital stock generates growth in the manufacturing sector. This is because manufacturing production uses only capital and capital is used only in manufacturing, thus capital market clearing in period 2 implies: $Q_{m,2} = K_2$. Note that this is just an application of the well known Rybczinski theorem. Thus, this result is also valid in a standard Hechsker-Ohlin model where both sectors use both production factors, as long as manufacturing is more capital-intensive than agriculture. Moreover, in this case the theorem states that when the capital stock grows, both capital and land reallocate away from agriculture into manufacturing. Thus, agricultural production shrinks while manufacturing production grows (Rybczynski, 1955). We refer to the increase in capital supply generated by agricultural productivity growth as the capital supply effect.

II.D From Theory to Data

The main objective of our empirical analysis is to assess to what extent an increase in agricultural productivity can lead to industrialization through its impact on capital accumulation. According to the model, this will depend on the relative strength of the demand and supply effects of agricultural technical change, which work in opposite directions. The demand effect consists in an increase in the value of the marginal products of land and capital in agriculture, which increase the demand for capital in this sector. Thus, for a given supply of capital, the demand effect generates a reallocation of capital towards agriculture. In turn, the supply effect emanates from the increase in savings which leads to capital accumulation. To achieve factor market equilibrium, this larger supply of capital requires an expansion of the capital intensive sector, manufacturing. Our empirical work attempts to follow each step of this mechanism by observing directly the variables involved and tracing the origin and destination of capital flows.

[10] An alternative would be to consider that savings increase because technology adoption is a transitory income shock. Note that in the example discussed above we are considering a small open economy which is the only country adopting the new technology. Then, international prices do not change and technology adoption generates a permanent increase in national income. However, if this technology is slowly adopted by several other countries, eventually the international price of the agricultural good falls, offsetting the initial increase in land rents.

The model describes a frictionless neoclassical economy where goods are internationally traded and production factors are not traded. As a result, it assumes no capital mobility across countries and perfect capital mobility within countries, as in classical international trade models. These assumptions are important to generate the capital supply effect. First, if capital moves perfectly across countries, then national savings do not lead to an increase in national investment. Thus, we should not expect capital flows towards the national manufacturing sector. Second, we need some degree of national mobility of capital, so that the financial sector is able to reallocate landowner savings across sectors and regions. In practice, Brazil is integrated to world capital markets and is a country of intermediate financial development. Thus, the answer to the question of whether the increase in agricultural profits generates national investment in manufacturing is informative about the importance of frictions in international relative to intra-national capital markets.

Finally, let us highlight that although the model describes a frictionless economy, our empirical strategy requires frictions in the interbank market and the credit market to identify the destination of the money generated by agricultural productivity growth. We think of the model as a benchmark describing the optimal direction of capital flows when manufacturing is more capital intensive than agriculture. Indeed, we take the finding that agricultural profits increased more than investment as an indication that capital should flow towards non-agricultural sectors. Thus, another open question we will attempt to address is to what extent the degree of financial integration across regions can affect the speed of structural transformation.

III Background on Genetically Engineered Soy in Brazil

In this section we provide background information on the technological change introduced by genetically engineered (GE) soy in Brazilian agriculture.

The main innovation of GE seeds is that they are genetically engineered to resist a specific herbicide (glyphosate). This allows farmers to adopt a new set of farming techniques that lowers production costs, mostly due to lower labor requirements for weed control. In particular, 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. The adoption of GE soy seeds increase profitability also because it requires fewer herbicide 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, Klotz-Ingram, and Jans 2002). Finally, no-tillage allows greater density of the crop on the field (Huggins and Reganold 2008).

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.[11] The new technology experienced a fast pace of adoption. 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 timing of adoption of GE soy seeds in Brazil coincides with 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.[12] 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.[13] 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.

IV Data

The main data sources are: the Credit Information System (SCR) of the Central Bank of Brazil for loan-level data, the Annual Social Information System (RAIS) of the

[11] In 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).

[12] Yearly 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.

[13] See section IV for a detailed description of this dataset.

Ministry of Labor for firm-level data, and the Municipal Bank Statistics (ESTBAN) for bank branch-level data. Additionally, we use data on agricultural outcomes from the Municipal Agricultural Production Survey (PAM) 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.

IV.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.[14] We use data from the Credit Information System covering the years from 1997 to 2010. 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.[15] In the current version of the paper, we focus on total outstanding loan amount.[16] 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.[17] Using worker level data, we constructed the following set of variables for each firm: employment, wage bill, sector of operation and geographical location.[18] ESTBAN reports balance sheet information at branch level for all commercial banks operating in Brazil. The main variables of interest are total value of deposits and total value of loans originated by each branch.[19]

[14] The 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.

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

[16] Loan 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.

[17] Employers are required by law to provide detailed worker information to the Ministry of Labor. See Decree n. 76.900, December 23^{rd} 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*).

[18] When 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.

[19] We 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

IV.A.1 Broad Stylized Facts from Raw Data

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 of RAIS, our analysis focuses on formal firms with at least one employee.[20] Second, the Credit Information system has a reporting threshold above which financial institutions are required to transmit loan information to the Central Bank.[21] 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 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.[22] 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 employing between 1 and 9 workers, small firms those employing between 10 and

individuals and loans to 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.

[20] Self-employed are not required to report information to RAIS.

[21] To 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).

[22] It 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.

49 workers, medium firms those employing between 50 and 99 workers, and large firms those employing 100 or 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.

IV.B Additional Datasets

Data on area cultivated with soy in each municipality is sourced 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 IBGE 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 and investments in agriculture from the Agricultural Census. The Agricultural Census is released at intervals of 10 years by the 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 and investments as reported in the Census refer to all agricultural activities.

Finally, to construct our measure of technical change in soy production 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.

V Empirics

Our empirical work aims 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 regions, 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 trace the reallocation of capital across regions, from rural to urban areas. For this purpose, we exploit differences in the geographical structure of the branch networks of Brazilian banks. We think of these banks as intermediaries that reallocate savings from soy producing (*origin*) municipalities to non-soy producing (*destination*) municipalities. We use the bank branch networks to construct exogenous credit supply shocks across different urban areas. We use this variation to assess whether municipalities more connected to soy-producing regions through bank branch networks experienced larger increases in aggregate bank lending.

Third, we trace the reallocation of capital towards firms located in destination municipalities. 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 use this variation to assess whether firms whose pre-existing lenders are more connected to soy-producing regions through bank branch networks experienced larger increases in borrowing and firm growth.

We divide this empirical section in three parts, which correspond to the three steps described above. For each step we first describe our identification strategy and then present empirical results. We start by describing the identification of local effects of agricultural technical change in subsection V.A and the empirical results in subsection V.B. Next, we describe our identification strategy to study the reallocation of capital towards destination municipalities through the bank branch network in subsection V.C and the empirical results in subsection V.D. Finally we describe our identification strategy to study capital reallocation towards firms located in destination municipalities in subsection V.E, and the empirical results in subsection V.F.

V.A Local Effects: Empirical Strategy

Our empirical strategy to study local effects – that is, effect of soy technical change felt within the boundaries of each municipality – builds on Bustos et al. (2016).[23] In particular, we implement a difference-in-difference strategy that exploits the legalization of GE soy seeds in Brazil as a source of time variation, and differences in the increase in potential soy yields due to the new technology across municipalities as a source of cross-sectional variation.

Our identification strategy relies on the fact that the adoption of GE soy seeds had a differential impact on potential yields in areas with different soil and weather characteristics. We obtain our measure of potential yields for soy from the FAO-GAEZ database. 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 FAO-GAEZ 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 potential yields to be a good predictor of the profitability of adopting GE soy seeds.

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

$$y_{jt} = \alpha_j + \alpha_t + \beta \log(A_{jt}^{soy}) + \varepsilon_{jt} \tag{7}$$

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 as reported in the FAO-GAEZ dataset described in section IV.[24] The change in potential soy yield from low to high inputs

[23]Since 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.

[24]In Bustos et al. (2016) we estimate a version of equation (7) where our measure of soy technical

corresponds to the timing of the legalization of GE soy seeds in Brazil, which occurred in 2003.

We control for differential trends across municipalities with heterogeneous initial characteristics in equation (7). This is because, although the soil and weather characteristics that drive the variation in A_{jt}^{soy} across geographical areas are plausibly exogenous, they might be correlated with the initial levels of economic and financial development across Brazilian municipalities.[25] First, we control for the share of rural population in a municipality in all specifications, which captures differential trends for municipalities with different initial urbanization rates. Additionally, we control for the following initial municipality characteristics: income per capita (in logs), population density (in logs) and literacy rate. All controls are sourced from the 1991 Population Census and interacted with year fixed effects.

V.B Local Effects: Empirical Results

First, we analyze the effect of soy technical change on the agricultural sector using data from the last two waves of the Brazilian Agricultural Census (1996 and 2006). We focus on the following outcomes at municipality-level: adoption of GE soy seeds, agricultural productivity, agricultural profits and agricultural investment per hectare.

To this end, we estimate the following first-difference version of equation (7):

$$\Delta y_j = \Delta\alpha + \beta\Delta\log(A_j^{soy}) + \Delta\varepsilon_j \tag{8}$$

Where Δy_j is the decadal change in outcome variables between 1996 and 2006 – the last two Agricultural census years, and $\Delta\log(A_j^{soy})$ is defined as $\log(A_j^{soy,HIGH}) - \log(A_j^{soy,LOW})$.

Columns 1 and 2 of Table II report the results of estimating equation (8) when Δy_j is the change in the share of agricultural land devoted to GE soy between 1996 and 2006. The point estimate of the coefficient on $\Delta\log(A_{jt}^{soy})$ reported in column 2 – in which we add all municipality controls – indicates that municipalities with one standard deviation larger increase in soy technical change experienced a 1.5 percentage points larger expansion in GE soy as a share of agricultural area area between 1996 and 2006. This corresponds to 24.4% of a standard deviation in the change of GE soy share observed in this period. Next, we estimate the effect of soy technical change on agricultural productivity, measured as the log of the total value of agricultural output per worker.[26] The estimated coefficients

change is in levels. We use logs in this setting to make equation (7) consistent with the measure of bank exposure presented in section V.C, which is obtained as a log-linear approximation of the equation describing local deposits in a given municipality.

[25]See Bustos et al. (2016) for a more detailed discussion.

[26]As described in section IV, monetary outcomes from the Census refer to all agricultural activities and not specifically to soy production.

reported in column 4 indicates that municipalities with one standard deviation larger increase in soy technical change experienced a 5.4 percent larger increase in agricultural productivity between 1996 and 2006.

The results reported in columns 1 to 4 are consistent with those reported in Bustos et al. (2016), and show that soy technical change predicts adoption of GE soy seeds and agricultural productivity growth at local level. We now turn to local effects not analyzed in our previous work. First, we investigate the effect of soy technical change on agricultural profits. Results are reported in columns 5 and 6 of Table II. 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. We then investigate what was the use of extra agricultural profits. In principle, they could have been reinvested in agriculture, channeled into consumption or savings. We start by measuring the effect of soy technical change on agricultural investment. Results are reported in columns 7 and 8 of Table II. The estimated 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. However, agricultural profits per hectare are three times larger than investment per hectare in the 1996 Agricultural Census baseline. Thus, taken together, these coefficients imply that for every R$10 increase in profits per hectare due to soy technical change, only around R$3.45 are reinvested in agricultural activities.

So far we have shown that agricultural profits were only in part reinvested in agricultural activities. If agricultural profits were partly saved, they could have taken the form of informal lending arrangements or could have been saved in the formal banking sector. We start by investigating the effect of soy technical change on deposits in local bank branches. We estimate equation (7) where y_j is the log of the total value of bank deposits in bank branches located in municipality j, which we define as the sum of deposits in checking accounts, saving accounts and term deposits. Data on bank outcomes is sourced from the ESTBAN dataset, which has detailed information on balance sheet and location of branches of all commercial banks operating in Brazil. As such, our analysis in this section focuses on municipalities with at least one bank branch.[27] Results are reported in columns 3 and 4 of Table III. The estimates indicate that municipalities with higher increase in soy technical change experienced a larger increase in local bank deposits during the period under study. The magnitude of the estimated coefficient in column 2 indicates that a municipality with a one standard deviation higher increase in soy technical change experienced a 8% larger increase in bank deposits in local branches. Notice that all estimates in Table III are obtained using yearly data from the ESTBAN dataset, which covers the period between 1996 and 2010. In columns 1 and 2 we therefore report the results

[27] During the period under study we have data on bank branches located in 3154 AMCs (75% of all Brazilian AMCs).

of estimating equation (7) over the same time period and using as outcome variable the area farmed with soy as a fraction of initial total agricultural area.[28] Notice that total agricultural area captures land devoted to all agricultural activities, including permanent and temporary crop cultivation, cattle ranching, fallow land, and forestry. The estimated coefficient in column 2 implies a large effect of soy technical change on soy expansion: a municipality with a one standard deviation higher soy technical change experienced a 1.9 percentage points larger increase in soy area as a share of agricultural area. Notice that the average share of soy in agricultural land across Brazilian municipalities is 5.1 percent (see Table I), so this effect corresponds to a 37 percent increase for the average municipality. We can then use the estimates obtained in columns 2 and 4 of Table III to back out the elasticity of bank deposits to soy expansion. The implied elasticity can be computed by dividing the estimated coefficient on soy technical change when the outcome is bank deposits (0.070) by the estimated coefficient on the same variable when the outcome is soy area share (0.017). Our estimates indicate that a 19 percent increase in the share of soy in local agricultural land is associated with a 4.1 percent increase in local bank deposits at municipality level.[29]

To sum up, our measure of soy technical change is a good predictor of the adoption of GE soy seeds. In addition, municipalities with larger increases in soy technical change also experienced larger increases in agricultural productivity and agricultural profits. We showed that extra agricultural profits were only in part reinvested in agricultural activities and local branches in areas with higher increase in soy technical change experienced an increase in deposits. This higher liquidity available to banks could have been lent locally, nationally or internationally. We start by estimating equation (7) when the outcome variable is the total value of loans originated by bank branches located in municipality j. Results are reported in columns 5 and 6 of Table III. Notice that lending includes loans to both 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 and implies that a municipality with a one standard deviation higher potential soy profitability experienced a 6.9% lower increase in loans originated by local branches. This suggests that municipalities that experienced larger increase in potential soy profitability are net "exporters" of capital within their bank branch network. We test this hypothesis more formally in columns 7 and 8 of Table III, where we estimate equation (7) when the

[28]The outcome variable 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.

[29]The implied elasticity is 4.1. A 1 percentage point increase in the area farmed with soy as a share of local agricultural land corresponds to a 19% increase for the average municipality (0.01/0.051=0.19). Notice also that a 1 percentage point increase in the soy share of agricultural land translates into around 1,000 additional hectares farmed with soy in the average municipality. This corresponds to a 3 million hectares increase at country level, or 24% of the total increase in soy area experienced in Brazil between 1996 and 2010 (12.3 million hectares, see Figure I). The estimated elasticity of local deposits to the increase in area farmed with soy in local agriculture is statistically different from zero (t-stat = 4.16).

outcome variable is net export of capital from a given municipality through the banking sector. We defined net capital export as total value of deposits minus total value of loans originated by bank branches located in municipality j, divided by total assets of the same branches. As shown, we find a positive and precisely estimated coefficient on $\log(A_j^{soy})$, which indicates that municipalities with higher increase in soy technical change experienced a larger net increase in capital export through the formal banking sector during the period under study.

V.C Capital Reallocation towards destination municipalities: Empirical Strategy

In section V.B we showed that the adoption of new agricultural technologies generates more profits than investments. This suggests that the capital supply effect dominates the capital demand effect. In this case, the model predicts that capital should reallocate towards the non-agricultural sectors. Because soy producing regions tend to be rural, this reallocation needs to take place both across sectors and regions. In this section, we explain how we use the structure of the bank branch network across Brazilian regions to trace the flow of funds from *origin* municipalities – soy producing areas generating savings deposits – to *destination* municipalities – municipalities towards which banks could reallocate funds generated by the soy boom.

To this end, we build a measure of destination municipality exposure to the GE soy-driven increase in deposits which exploits differences in the geographical structure of bank branch networks. This measure captures the potential credit supply increase in each *destination* municipality. We call this measure: destination municipality exposure. Destination municipality exposure is higher for municipalities served by banks more exposed to the GE-soy driven increase in deposits through their branch network. Before describing this strategy in more details, let us illustrate this source of variation with one example. In Figure VII we show the geographical location of the branches of two Brazilian banks with different levels of exposure to the soy boom. The Figure reports, for each bank, both the location of bank branches across municipalities (red dots) and the increase in area farmed with soy 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 a large increase in soy farming following the legalization of GE soy seeds. On the contrary, the branch network of bank B mostly encompasses regions with no soy production.[30] Therefore, non-soy producing municipalities served by bank A received a larger GE-soy driven increase in credit supply than those served by bank B. Then,

[30] 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 area but our exogenous measure of potential increase in soy profitability, which only depends on soil and weather characteristics.

we study the effect of municipality exposure on aggregate lending outcomes in destination municipalities. In particular, we focus on total loans issued by banks in destination municipalities, the share of agricultural and non agricultural lending, and credit market participation. We present the empirical results in subsection V.D

The first step in the construction of municipality exposure estimates the increase in national deposits of each bank due to technical change in soy production. In what follows we explain how we obtain such estimate. First note that, for each bank b, national deposits can be obtained by aggregating deposits collected in all municipalities where the bank has branches:

$$Deposits_{bt} = \sum_{o \in O_{bt}} deposits_{bot} \tag{9}$$

where $Deposits_{bt}$ are national deposits of bank b, $deposits_{bot}$ are local deposits of bank b in origin municipality o, and O_{bt} is the set of all origin municipalities where bank b has branches at time t.

We assume that local deposits in branch bo at a given point in time are a log-linear function of local income. Because income is composed both of agricultural and non-agricultural income, we can approximate the effect of agricultural productivity growth on income as follows:

$$dlog(Y_o) = (Y_o^a / Y_o) dlog(A_o^a) \tag{10}$$

where Y_o is total income in origin municipality o, Y_o^a is agricultural income and A_o is agricultural productivity.[31] We proxy for the agricultural share in total income by using the share of land devoted to agriculture in each municipality: T_o^a / T_o. Then, we can estimate the effect of local agricultural technical change on the local deposits of bank b in municipality o as follows:

$$\log(deposits)_{bot} = \alpha_b + \alpha_o + \alpha_t + \beta \left(\frac{T_o^a}{T_o} \right)_{t=0} \log(A_{ot}^{soy}) + \varepsilon_{bot} \tag{11}$$

where 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 $\left(\frac{T_o^a}{T_o} \right)_{t=0}$ is the share of agricultural land in municipality o in the initial year of our sample, which we source from the 1996 Agricultural Census.

Next, we would like to obtain an equation for the increase in national deposits of each bank due to technical change in soy. Our strategy is to obtain a log-linear approximation

[31] To derive equation (10) note that total income in municipality o given its initial endowments of land and physical capital is $Y_o = r_o^T T_o + r_o^K K_o$. Then, by replacing the factor prices derived in equations (4) and (5) the model we obtain $Y_o = P^a A_o^a T_o + P^m K_o$. Next, log differentiating with respect to A_o^a and using the fact that the manufacturing price is set internationally, we get: $dlog(Y_o) = (Y_o^a / Y_o) dlog(A_o^a)$.

of the change in aggregate deposits, as follows:

$$d\log\left(Deposits\right)_b \approx \sum_{o\in O_b} \omega_{bo} d\log\left(deposits\right)_{bo} \tag{12}$$

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. 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. Notice that we can approximate equation (12) in levels as follows:

$$\log Deposits_{b,t} \approx \log Deposits_{b,t=0} + \sum_{o\in O_b} \omega_{bo} d\log\left(deposits\right)_{bo,t-t=0}$$

where $\log Deposits_{b,t}$ is the national level of deposits of bank b at any given point in time t, which we approximate with its initial level at $t = 0$ plus the weighted sum of changes in deposits in each of the branches of bank b between $t = 0$ and t. Next, we substitute $d\log\left(deposits\right)_{bot}$ by equation (11) and obtain:

$$\begin{aligned}\log Deposits_{b,t} \approx\ & \log Deposits_{b,t=0} + \sum_{o\in O_b} \omega_{bo,t=0}\beta\left(\frac{T_o^a}{T_o}\right)_{t=0}\left(\log A_{o,t}^{soy} - \log A_{o,t=0}^{soy}\right)\\ & + \left(\alpha_t - \alpha_{t-1}\right) + \sum_{o\in O_b} \omega_{bo,t=0}\left(\varepsilon_{bot} - \varepsilon_{bo,t=0}\right)\end{aligned}$$

Adding bank and time fixed effects and an approximation error, we obtain:

$$\log Deposits_{bt} = \gamma_b + \gamma_t + \beta \underbrace{\left[\sum_{o\in O_b} \omega_{bo,t=0}\left(\frac{T_o^a}{T_o}\right)_{t=0}\left(\log A_{o,t}^{soy}\right)\right]}_{\text{Bank Exposure}} + \eta_{bt} \tag{13}$$

where:

$$\gamma_b = \log deposits_{b,t=0} + \beta\sum_{o\in O_b} \omega_{bo,t=0}\left(\frac{T_o^a}{T_o}\right)_{t=0}\left(\log A_{o,t=0}^{soy}\right)$$

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

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

Notice that equation (13) describes the relationship between actual national deposits of bank b at any point in time and the increase in national deposits of bank b that is predicted by a change in the vector of potential soy yields in all municipalities due to the legalization of GE soy. We are going to define the summation in brackets inside equation (13) as our measure of bank exposure to the deposit increase driven by soy technical change.[32]

The methodology outlined above permits to estimate the amount of deposits obtained by each bank thanks to the soy technical change in origin municipalities. Next, we want to track the destination of these funds. In principle, banks could lend the funds in the national or international interbank market in which case it would be hard for us to trace where the money goes. However, if there are frictions in the interbank market, banks are more likely to finance their loans with their own deposits. In this case, we can trace intra-national capital flows by exploiting differences in the geographical structure of bank branch networks. To do this, we make the simple assumption that each bank responds to the growth in deposits by increasing the supply of funds proportionally in all municipalities where it has branches. Thus, each destination municipality exposure is a weighted average of the exposure of all the banks where the weights are the initial market share of each bank in the municipality, as follows:

$$MunicipalityExposure_{dt} = \sum_{b \in O_d} \omega_{bd,t=0} \underbrace{\left[\sum_{o \in O_b} \omega_{bo,t=0} \left(\frac{T_o^a}{T_o} \right)_{t=0} \left(\log A_{o,t}^{soy} \right) \right]}_{\text{Bank Exposure}} \tag{14}$$

where ω_{bd} captures the lending market share of bank b in destination municipality d and it is constructed as the value of loans issued by branches of bank b in municipality d divided by the total value of loans issued by branches of all banks operating in municipality d (whose set we indicate with O_d). The weighting should capture 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 municipalities where a bank has branches. To keep exogeneity of the credit supply shock, we use lending market shares of each bank ($\omega_{bd,t=0}$) in 1996, before the new soy technology was legalized in Brazil (or even patented in the US). Similarly, we use 1996 deposit shares for the weights used in the bank exposure measure ($\omega_{bo,t=0}$).

[32]Notice that one alternative to this strategy is be to estimate equation (11) in the data 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 (11) in logarithms, $(\widehat{deposits})_{bot}$ is a non-linear function of the estimated parameters. This leads to both identification and inference problems. All derivations and a detailed discussion of this alternative approach is available upon request.

V.D Capital reallocation towards destination municipalities: Empirical Results

In this section we study the effect of municipality exposure as described in equation (14) on aggregate bank lending and credit market participation in destination municipalities. To this end, we estimate the following equation:

$$y_{dt} \quad = \quad \alpha_d + \alpha_t + \beta MunicipalityExposure_{dt} + \varepsilon_{dt} \tag{15}$$

We focus on two main outcome variables: total bank lending and the share of bank lending to non-agricultural sectors in destination municipality d and year t. Data on bank lending is from the ESTBAN dataset and covers the years 1996 to 2010, the same time span and set of municipalities covered in section V.B where we studied the local effects of soy technical change on deposits and lending.

Table IV reports the results of estimating equation (15). We find that municipalities with larger exposure to the soy-driven deposit increase through the bank network experienced a larger increase in aggregate lending. The magnitude of the estimated coefficient reported in column 1 implies that a municipality with a one standard deviation larger exposure experienced around 7% larger increase in aggregate lending. This result is driven by non-soy producing destination municipalities. In columns 2 and 3, we split the sample in soy-producing and non-soy producing municipalities.[33] Each of these groups accounts for around half of the observations used in column 1. The estimated coefficient in the soy-producing sample is 0.054 and not statistically significant, while the estimated coefficient on the non-soy producing sample is 0.580 and strongly significant. These results indicate a reallocation of capital towards non-soy producing regions.

Next we study whether this increase in lending has been directed towards agricultural or non-agricultural sectors. The results of estimating equation (15) when the outcome variable is the share of lending outside of the agricultural sector is reported in column 4. We find that municipalities with a one standard deviation larger exposure to the soy-driven deposit boom experienced 2.2 percentage points larger increase in non-agricultural lending as a share of total lending. This effect is largely concentrated in non-soy producing region, as shown in columns 5 and 6.

The findings discussed above are consistent with the capital supply mechanism emphasized by the model: agricultural technical change can increase savings and lead to a reallocation of capital towards the capital intensive sector, manufacturing. Our empirical analysis permits to quantify this effect by comparing the speed of capital reallocation across sectors in non-soy producing municipalities with different degrees of financial inte-

[33] Non-soy producing municipalities are those with no agricultural area farmed with soy at any point in time between 1996 and 2010.

gration with the soy boom area. During the period under study (1996-2010), the share of non-agricultural lending increased from 74.6 to 83.5 percent in the average non-soy producing municipality. However, the degree of capital reallocation away from agriculture varied extensively across municipalities: the interquartile range was 23 percentage points. Our estimates imply that the differences in the degree of financial integration with the soy boom area can explain 15 percent of the observed differences in the increase in non-agricultural lending share across non-soy producing municipalities.

Overall, these results indicate that new agricultural technologies can generate structural transformation in regions not directly affected by the new technologies. Two caveats with this specification are in order. First, this specification does not allow us to disentangle the direct effect of capital reallocation from the labor supply or product demand channels of agricultural productivity growth. For example, destination municipalities served by more exposed banks might also be better connected to soy-producing regions through transportation or migrant networks. Therefore, in section V.E, we propose an identification strategy that aims at disentangling the capital supply channel from other channels using loan-level and firm-level data. Second, the ESTBAN dataset used to construct the agricultural and non-agricultural lending shares used as outcomes in this section includes lending to both firms and individuals. Therefore, in section V.F, we use loan-level data to more precisely identify credit flows to firms in different sectors.

Finally, in Table V, we study the effect of *destination* municipality exposure on credit market participation. As shown in section IV.A.1, Brazil experienced a large increase in the share of firms with access to bank credit during the period under study. To this end, we estimate a version of equation 15 where the outcome variable is the share of firms with access to bank credit in destination municipality d and year t.[34] Given the effect of municipality exposure on aggregate lending is concentrated in non-soy producing regions, we estimate this equation exclusively on non-soy producing municipalities. We find that municipalities with larger exposure to the soy boom through the bank network experience larger increase in firm access to bank credit. The magnitude of the estimated coefficient reported in column 1 implies that a municipality with a one standard deviation larger exposure to the soy-driven deposit increase experienced a 0.3 percentage points larger increase in the share of firms with access to bank credit. The average credit participation across municipalities in our sample is 5.6%, which implies that a one standard deviation increase in exposure would increase credit participation in the average municipality from 5.6% to 5.9%.[35] In columns 2 and 3, we report the results of estimating the same equation

[34]We define access to bank credit using the 50,000 1997 R$ 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.

[35]Notice that the average credit market participation across municipalities is slightly lower than the credit market participation at national level reported in Figure II. This is because municipalities are equally weighted in Table V, and municipalities with a larger number of firms tend to be more urban and financially developed.

when the outcome variable is the share of firms with access to bank credit in different firm size categories: micro and small firms in column 2, medium and large in column 3, all defined as in section IV. Here we find the effect of municipality exposure on access to bank credit is concentrated exclusively in micro and small firms.

V.E Capital reallocation towards destination firms: Empirical Strategy

The findings presented in section V.D are consistent with the capital supply mechanism emphasized by the model. However, to the extent that destination municipalities which are more connected to origin municipalities through bank-branch networks are also more connected through the transportation or commercial networks, it is possible that our estimates are capturing the effects of agricultural technical change through the labor supply or product demand channels. To make progress on this front, in this section we propose a different empirical strategy which permits to control for labor supply and product demand shocks in destination municipalities. In particular, we trace the reallocation of capital towards firms located in destination municipalities. For this purpose, we match 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 use these shocks to assess whether firms whose pre-existing lenders are more connected to soy-producing regions through bank branch networks experienced larger increases in borrowing and employment growth. This empirical strategy permits to compare firms operating in the same sectors and municipality but initially borrowing from different banks. This allows to control for labor supply and product demand shocks in destination municipalities and thus isolate the capital supply channel. In what follows we explain this identification strategy in more details.

We start by characterizing the relationship between bank deposits and firm borrowing. To this end, we assume that loans of firm i from bank b are described as follows:

$$loans_{ibt} = I_{ibt} r_{bt}^{\lambda} u_{bit}$$

where I_{ibt} is an indicator variable taking the value of one when there is a bank-firm relationship. 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 $I_{ib,t=0} > 0$ – i.e. we condition on pre-existing bank-firm relationships – and take logs to obtain:

$$\log(loans_{ibt}) = \delta_i + \delta_t + \delta_b + \lambda \log r_{bt} + \varepsilon_{bit} \tag{16}$$

Note that because we condition on $I_{ib,t=0} > 0$, our estimates on this sample of firms only capture the "intensive margin." That is, we only analyze the increase in lending from banks with whom firms had pre-existing relationships.

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

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

Third, we substitute the equation above on equation (16) to obtain our main estimating equation:

$$\log(loans_{ibt}) = \delta_i + \delta_t + \delta_b + \lambda\mu \log Deposits_{bt} + e_{bit} \tag{17}$$

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 generated by soy technical change – our measure of bank exposure as defined in equation (13).

We therefore substitute equation (13) in our structural equation of interest (17), to obtain:

$$\log(loans_{ibt}) = \nu_i + \nu_t + \nu_b + \beta BankExposure_{bt} + \varepsilon_{bit} \tag{18}$$

where:

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

and

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

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.[36] 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:

$$\log(loans_{idsbt}) = \nu_i + \nu_b + \nu_{dt} + \nu_{st} + \beta BankExposure_{bt} + \varepsilon_{bit} \tag{19}$$

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.[37] In turn, ν_{dt} are destination municipality interacted with time fixed effects, and ν_{st} are industry interacted with time fixed effects.

In addition to study the effect of capital reallocation on firm borrowing, we are also 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 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 firm-level specification:

$$\log(y_{idst}) = \nu_i + \nu_{dt} + \nu_{st} + \beta FirmExposure_{it} + \varepsilon_{bit} \tag{20}$$

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

[37] Sector fixed effects are 2-digits sectors according to the Brazilian CNAE 1.0 classification. Firms in our sample are present in 56 2-digit CNAE 1.0 sectors.

where:

$$FirmExposure_{it} = \sum_{b \in B} \pi_{ib,t=0} \; BankExposure_{bt}$$

and

$$\pi_{ib,t=0} = \frac{loans_{ib,t=0}}{Loans_{i,t=0}}$$

The variable y_{idst} denotes an outcome such as total wage bill or employment in firm i, located in destination municipality d, operating in industry s at time t,. Our measure of firm exposure is defined as a weighted average of bank exposure of all lenders with which firm i had a credit relationship in the pre GE-soy legalization period, which correspond to the years 2001 and 2002 in the Credit Registry Data. The weights correspond to the share of borrowing of firm i from bank b in 2001 and 2002 as a share of total borrowing of firm i in the same years. We use pre-existing bank relationships 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. Notice that this implies that we use the exposure of the pre-2003 lenders for all years in which a firm is present in our sample, no matter whether the firm is borrowing or not from those lenders in the years after GE soy legalization. Since the set of lenders used to construct this measure is defined in the initial period and it is time invariant for each firm, the bank fixed effects ν_b are effectively absorbed by firm fixed effects ν_i in this specification.

V.F Capital reallocation towards destination firms: Empirical Results

V.F.1 Bank aggregate deposits and exposure

In the following subsections we study whether larger increases in bank deposits due to soy technical change affected credit supply and firm growth. Before presenting these results, in this subsection we test the relationship between aggregate deposits of bank b and the increase in aggregate deposits for the same bank that is predicted by our measure of bank exposure. This relationship is described by equation 13 in section V.C, which we report below for the reader's convenience:

$$\log Deposits_{bt} = \gamma_b + \gamma_t + \beta BankExposure_{bt} + \eta_{bt} \tag{13}$$

Table VI reports the results of estimating equation (13) when the outcome variable is aggregate deposits of bank b, and bank-year observations are weighted by initial bank size.[38] Aggregate deposits for each bank are obtained summing branch level deposits from ESTBAN.[39] The point estimate on *BankExposure* is positive and significant, which indicates that banks more exposed to soy technical change through their branch network

[38] As captured by bank assets in the initial year.

[39] We focus on the years 2001 to 2010 in order to match the same time period used in the firm-level analysis presented in the next subsections.

experienced higher increase in aggregate deposits. The magnitude of the estimated coefficient reported in column 1 is 1.42. It indicates that a 1 percent increase in aggregate deposits of bank b predicted by the change in the vector of potential soy yields correspond to a 1.42 percent increase in actual national deposits of the same bank. In other words, changes in our measure of predicted deposits are associated with changes in actual deposits of similar magnitude.[40] Columns 2 to 4 show that this effect is not driven by other initial bank characteristics such as bank size or the deposit-to-asset ratio. Finally, in Figures VIII (a) and (b) we report partial correlations between changes in bank exposure and changes in the log of aggregate deposits at bank level, weighting and without weighting by initial bank size respectively.[41] As shown, our estimates are not driven by extreme observations or weighting by bank size.

V.F.2 Bank-firm level specification

In this section we study the effect of the soy-driven increase in deposits of a given bank – our measure of bank exposure – on firm borrowing from that same bank.[42]

Table VII shows the results of estimating equation (19), described in section V.E and reported below for convenience:

$$\log(loans_{ibdst}) = \nu_i + \nu_b + \nu_{dt} + \nu_{st} + \beta BankExposure_{bt} + \varepsilon_{bit} \tag{20}$$

where i indexes firms, b indexes banks, d indexes the destination municipality where the firm is located, s indexes sectors, and t indexes time. The outcome variable is the log of the monetary value of outstanding loan balance of firm i from bank b. The coefficient of interest in this specification is the one on bank exposure (β), which captures the effect of exposure of bank b on the outstanding loan balance of firm i from the same bank.

Table VII reports the estimated β. We start by estimating equation (19) in a specification with firm, bank and time fixed effects in column 1. The estimated coefficient on the variable $BankExposure$ is positive, indicating that firms with pre-existing relationships with more exposed banks experienced a larger increase in borrowing from those banks.

[40] We think that one reason why our estimate of β is larger than one is that our measure of Bank exposure is a first order approximation to changes in aggregate deposits holding the bank branch network constant. Thus, changes in the bank branch network are in the error term. It is very likely that the soy boom might have led banks to open new branches which capture deposits. Thus, our measure of bank exposure might underestimate the effect of the soy shock on aggregate deposits.

[41] This is equivalent to a first difference version of equation (13) obtained after partialling out year fixed effects and bank initial characteristics interacted with linear time trends and then averaging bank exposure and log deposits for each bank in the years before (2001-2002) and after (2003-2010) the legalization of GE soy seeds.

[42] We apply two restrictions to our sample. First, as explained in section V.E, we focus on firms operating in non-soy producing regions. Second, in order to minimize sample selection, we focus our analysis on the period 2001-2010, i.e. the years after the reporting threshold of the Credit Registry was lowered to 5,000 BRL. As shown in Figure II, in 2001 only around 7 percent of Brazilian firms had access to finance when using the 50,000 BRL reporting threshold. In the same year, 31 percent of Brazilian firms had access to finance under the 5,000 BRL reporting threshold, as shown in Figure A1 of the Appendix.

In column 2 we add municipality and sector fixed effects, both interacted with time fixed effects. Notice that we find similar point estimates when controlling for municipality and sector-level shocks. This suggests that the increase in firm borrowing is driven by the capital supply effect of agricultural technical change and not the labor supply or product demand effects. We can use this estimate to back out the implied elasticity of firm loans to bank deposits due to the soy shock. In particular, we can divide the estimated coefficient on bank exposure when the outcome is firm loans (0.277) by the estimated coefficient on bank exposure when the outcome is bank deposits (1.43), to obtain 0.19. This implies that 1 extra dollar of bank deposits in *origin* municipalities due to the soy shock translated into 19 extra cents lent to firms operating in non-soy producing municipalities.

In column 4 we augment equation (19) with firm fixed effects interacted with time fixed effects. This specification fully captures firm-specific demand shocks (Khwaja and Mian 2008), and only exploits variation across banking relationships within firm to identify the coefficient β. As a consequence, it can only be estimated using firms with multiple lending relationships in both the pre and the post GE soy legalization period. The estimated coefficient is positive, which implies that banks with larger exposure to the soy-driven deposit shock relative to other banks also increased their lending by more to the same firm. Notice also that the magnitude of the estimated coefficient is similar to the one obtained without firm fixed effects interacted with time fixed effect on the same sample of firms. This indicates that the effect of bank exposure on firm borrowing is driven by credit supply forces rather than unobservable firm-specific demand shocks correlated with lender exposure.[43] Overall, the coefficients reported in Table VII support the validity of our identification strategy.

Next, we study the effect of bank exposure on loans by sector of operation of the borrowing firm. To this end, we estimate equation (19) separately for borrowers operating in agriculture, manufacturing, services, and other sectors.[44] Table VIII reports the results. We find positive coefficients for firms in all sectors, with the largest and precisely estimated effects in manufacturing and services. The magnitude of the estimated coefficients in column 2 and 3 indicates an elasticity of firm loans to bank deposits due to the soy shock of 0.21 in manufacturing and 0.19 in services. These elasticities are smaller and not statistically significant in agriculture and other sectors (0.087 and 0.16 respectively).

Taking into account differences in average loan size and number of firms across sectors, these estimates indicate that out of 1 R$ of new loans in destination municipalities from

[43] Under certain assumptions regarding the functional form of the underlying model describing borrowing of firm i from bank b, the difference in point estimates between specifications that include firm fixed effects and those that do not captures the size of the bias induced by endogenous matching between firms and banks (see Khwaja and Mian 2008).

[44] Services 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. Other sectors include: public administration, education, health, international organizations, extraction, and public utilities.

the soy-driven deposit shock, 0.5 cents were allocated to firms in agriculture, 40 cents to firms in manufacturing, 47.7 cents to firms in services and 11.8 cents to firms in other sectors.[45]

Overall, the results presented in this section indicate that firms with pre-existing relationships with banks that were more exposed to the soy-driven increase in deposits in *origin* municipalities experienced a larger increase in borrowing from those banks. In addition, these results show that new capital originated from the soy-driven increase in deposits and reallocated to non-soy producing regions through the bank branch network was mostly lent to firms in manufacturing and services.

V.F.3 Firm level specification: real effects

In the previous section we showed that firms with pre-existing relationships with more exposed banks experienced a larger increase in borrowing from those banks. In this section we study the effect of firm exposure to the soy shock through all their pre-existing bank relationships on firm growth. To this end, we estimate equation (20), as described in section V.E and reported below for convenience:

$$\log(y_{idsbt}) = \nu_i + \nu_t + \nu_b + \nu_{dt} + \nu_{st} + \beta BankExposure_{bt} + \varepsilon_{bit} \tag{21}$$

In terms of firm-level outcomes, we focus on two main variables: 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 results are reported in Table IX. We find positive real effects on firm size. Firms whose pre-existing lenders have a larger exposure to the soy-driven deposit increase experienced a larger growth in employment and wage bill. In contrast with the loan estimates discussed in subsection V.F.2, we find that our estimated real effects fall to almost half when we control for municipality and sector-level shocks. This can be seen, for example, by comparing columns 1 and 2 in Table IX. The coefficient on firm exposure when the outcome is employment goes from 0.281 to 0.165 when adding municipality and sector fixed effects interacted with year fixed effects. This finding indicates that municipalities more connected through bank branch networks might also be more connected through transportation or commercial networks, thus are more likely to receive not only capital supply shocks but also labor supply and product demand shocks due to agricultural productivity growth. As a result, firm-loan-

[45]This quantification is obtained as follows. First, we multiply the estimated coefficient on bank exposure by the average loan size in the years 2001 and 2002 in each sector. This gives us the estimated increase in loan size for the average firm in each sector, in response to a unit increase in exposure of its main lender. Second, we multiply this estimate by the average number of firms operating in each sector in destination municipalities in our sample in the years 2001 and 2002. This multiplication gives us an estimate of the *total* increase in the value of loans of firms in each sector in response to a unit increase in exposure of their lenders. Finally, we use these estimates of *total* increase in loan value in each sector to compute the allocation across-sectors of 1 R$ of new loans in destination municipalities from the soy-driven deposit shock.

level data is necessary to separately identify the effects of the capital supply channel on the allocation of labor across sectors. In terms of magnitudes, when we focus on the estimates presented in columns 2 and 4, the estimated coefficients indicate that a firm whose pre-existing lenders have a 1 standard deviation higher increase in deposits due to soy technical change experienced a 3.8% larger increase in employment and a 5.2% larger increase in wage bill.

Next, we estimate the same equation by sector of operation of each firm. Table X reports the results. As shown, the average effects of firm exposure on firm size are positive and similar in size in agriculture, manufacturing and services, while small and not statistically significant for firms operating in other sectors. These estimates, along with differences in average firm size and number of firms in each sector, can be used to compute the allocation of extra workers across sectors for a given increase in firm exposure. Our estimated coefficients indicate that out of 100 additional workers in destination municipalities due to the soy-driven deposit shock, 1.7 were employed in agriculture, 32.1 in manufacturing, 62.6 in services and 3.6 in other sectors. To sum up, our results indicate that reallocation of capital from *origin* to *destination* municipalities had real effects on employment, and these effects were concentrated in the manufacturing and services sectors.

VI Concluding Remarks

This paper studies the effect of agricultural productivity on structural transformation in open economies through its impact on capital accumulation. The empirical analysis is focused on the widespread adoption of genetically engineered soy in Brazil. This new technology allows farmers to obtain the same yield with lower production costs, thus increasing agricultural profits. The effect of the new agricultural technology on structural transformation via capital accumulation depends on several features of the environment. First, the relative strength of the demand and supply effects of agricultural technical change, which, as highlighted in our model, work in opposite directions. The finding that the adoption of genetically engineered soy seeds generated more profits than investment in agriculture suggests that the supply effect dominates. Indeed, we find a positive effect of GE soy adoption on deposits in local bank branches. In this case, the model predicts that capital reallocates towards non-agricultural sectors. Because in our setting soy producing regions tend to be rural, this reallocation needs to take place both across sectors and regions. Indeed, branches located in soy producing areas were net capital exporters within their bank network, and capital was reallocated towards other regions. Thus, a second key feature of the environment is the degree of financial integration across regions. We find that regions more financially integrated with the soy boom area experience faster structural transformation. In particular, 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. Real effects were concentrated in non-agricultural sectors. These findings indicate that agricultural productivity growth can lead to structural transformation through its impact on capital accumulation.

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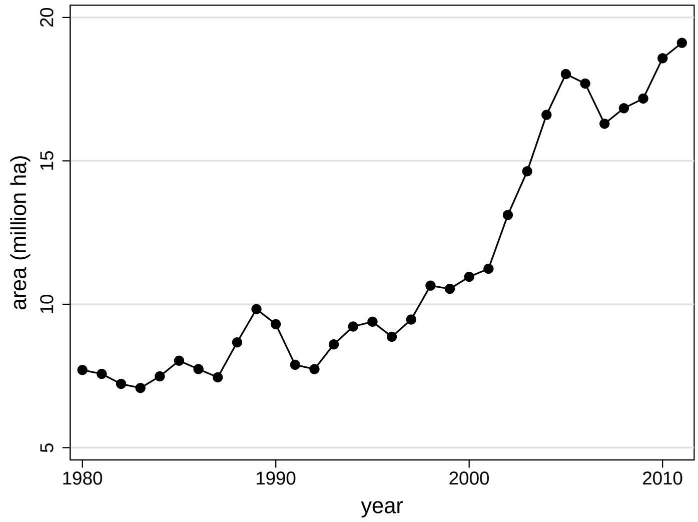
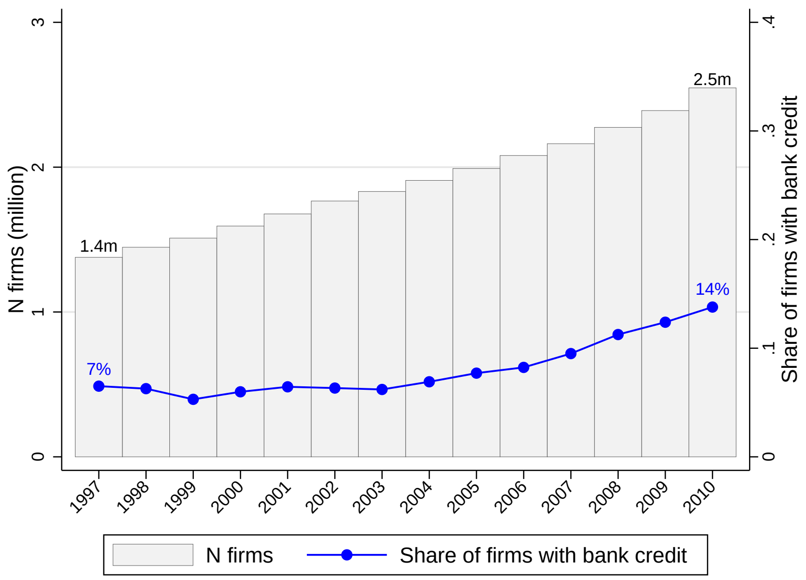
Figures and Tables

Figure I: Evolution of Area Planted with Soy in Brazil



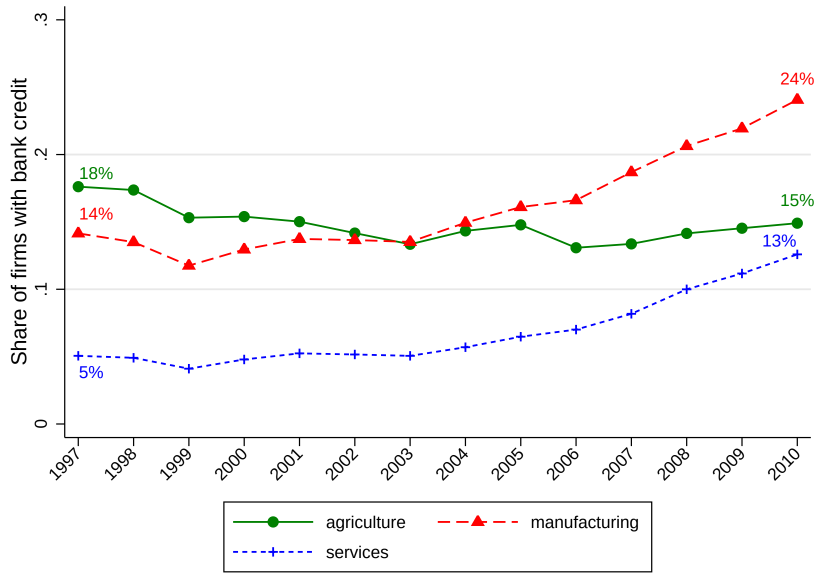
Notes: Data source is CONAB, *Companhia Nacional de Abastecimento*, which is an agency within the Brazilian Ministry of Agriculture. CONAB carries out monthly surveys to monitor the evolution of the harvest of all major crops in Brazil: the surveys are representative at state level and are constructed by interviewing on the ground farmers, agronomists and financial agents in the main cities of the country.

Figure II: Share of Firms with Bank Credit Brazil: 1997-2010



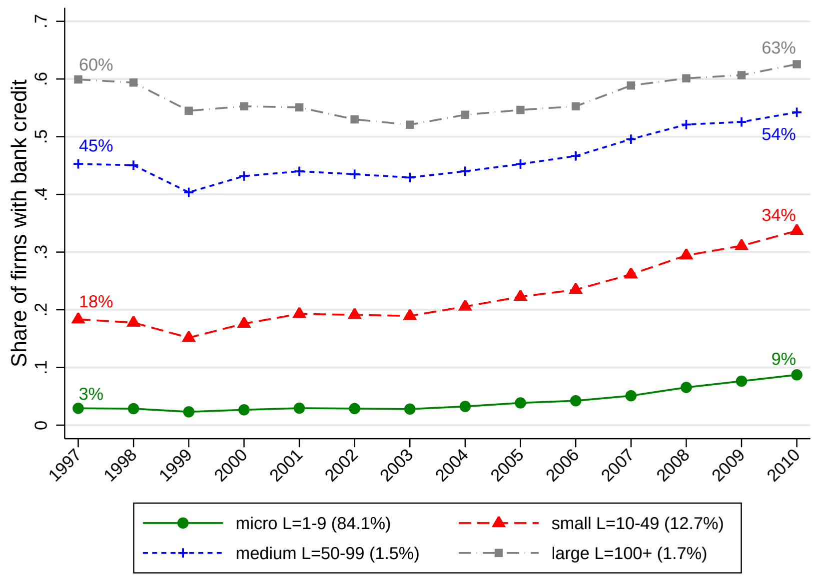
Notes: Sources are the Credit Information System of the Central Bank of Brazil and RAIS. Authors' calculation from micro-data. Access to bank credit is defined as an outstanding credit balance with a financial institution of at least 50,000 1997 BRL.

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 with a financial institution 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 with a financial institution of at least 50,000 1997 BRL. Numbers in parenthesis are the percentage of firms in each size category in 1997.

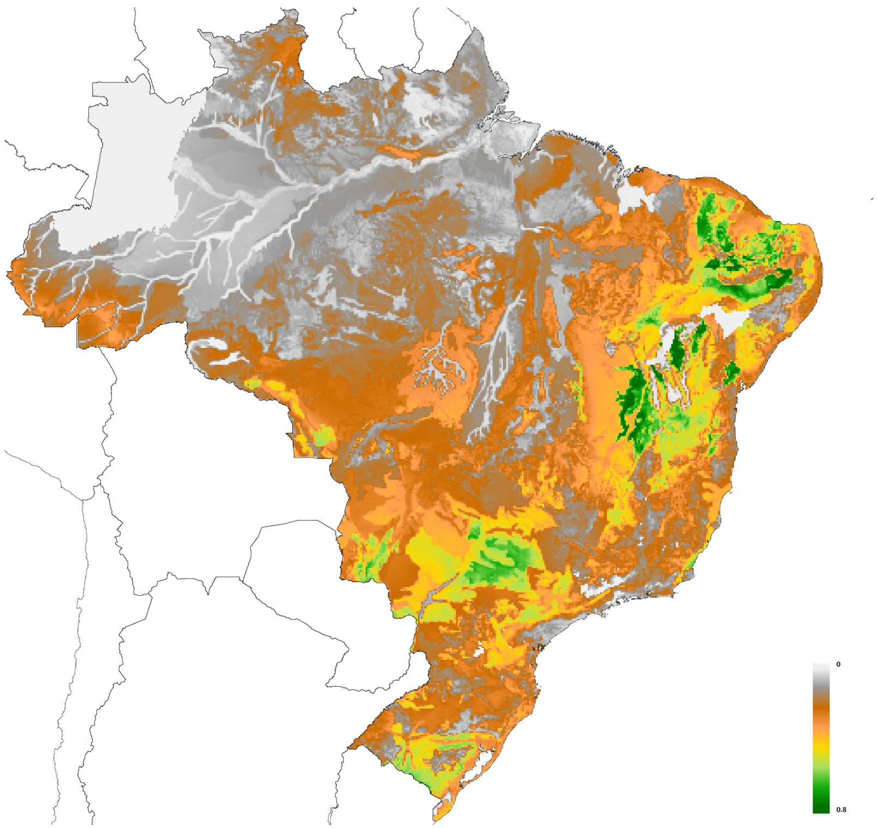


FIGURE V: POTENTIAL SOY YIELD UNDER LOW AGRICULTURAL TECHNOLOGY

Notes: Data source is FAO-GAEZ. Units are tons per hectare.

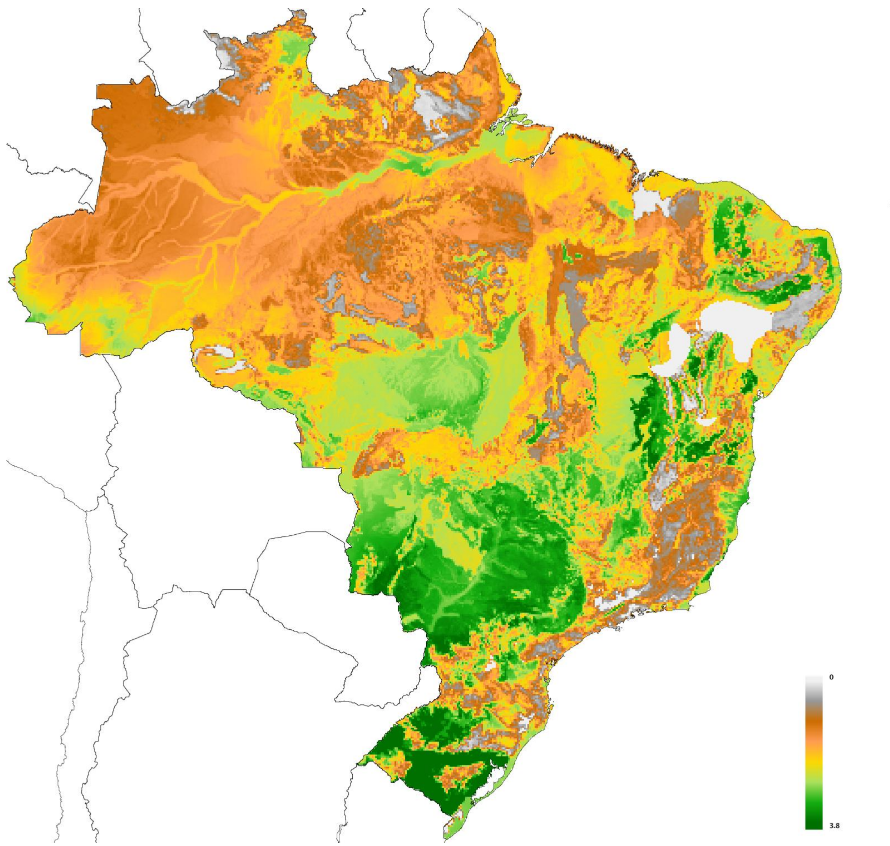
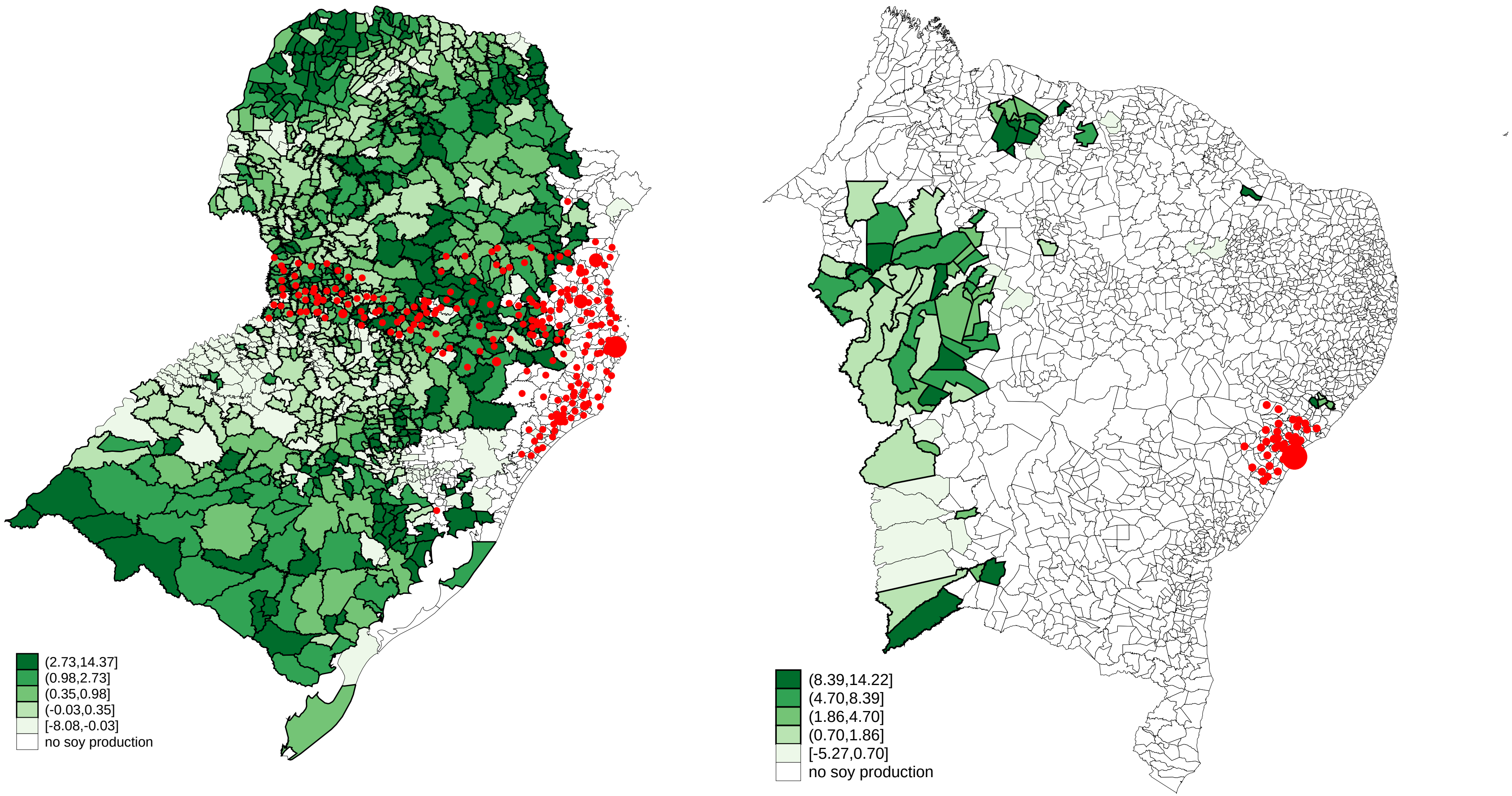


FIGURE VI: POTENTIAL SOY YIELD UNDER HIGH AGRICULTURAL TECHNOLOGY

Notes: Data source is FAO-GAEZ. Units are tons per hectare.

Figure VII: Bank Networks and Increase in Soy Revenues

(a) Bank A (b) Bank B

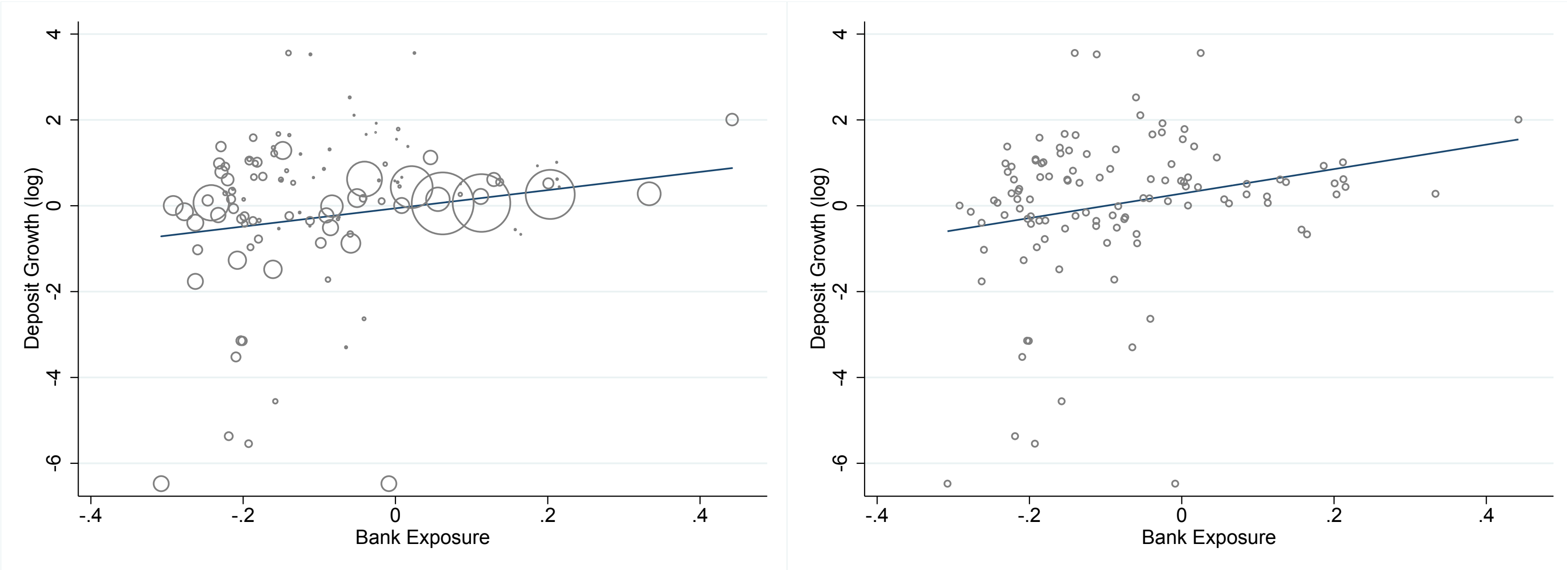


Notes: Data sources are ESTBAN for bank branch location and the Municipal Agricultural Production Survey for revenues from soy production.

Figure VIII: Bank Deposits and Bank Exposure

(a) Partial Correlation, Weighted by Bank Size

(b) Partial Correlation, Unweighted



Notes: The graphs show the partial correlations between changes in bank exposure and changes in log deposits at bank level. Changes are computed after averaging bank exposure and log deposits for each bank before (2001-2002) and after (2003-2010) the legalization of GE soy seeds. Bank exposure and log deposits are averaged after partialling out year fixed effects, as well as log of bank assets and deposit-to-asset ratio (both observed in 1996) interacted with linear time trends. This is therefore equivalent to a first difference version of equation (13). The results of estimating equation (13) in levels are reported in Table VI, column 4. In these graphs we focus on bank exposure values (after partialling out fixed effects and bank controls) between -0.5 and +0.5. This is for a more transparent visualization of the data and has negligible effects on the slope of the regression. The estimated slope using the same 121 banks as in Table VI is 1.81 (t-stat = 2.25), while if we focus on bank exposure values between -0.5 and +0.5 (N=114), the estimated slope is 2.12 (t-stat=2.44). Panel (b) reports the unweighted version of Panel (a).

Table I: Summary Statistics

variable name	mean	st.dev.	N
independent variables:			
$\Delta log(A_{jt}^{soy})$	1.917	0.466	3,020
$log(A_{jt}^{soy})$	-0.285	1.136	44,406
$MunicipalityExposure$	-0.041	0.242	44,406
$BankExposure$	0.069	0.198	1,052
outcome variables at municipality-level:			
$\Delta \frac{GESoyArea}{AgriArea}$	0.015	0.064	3,020
ΔAgri Productivity	0.504	0.695	3,020
ΔAgri Profits per he (pct points)	0.319	1.867	3,020
ΔAgri Investment per he (pct points)	0.475	1.042	3,020
Soy Area / Agricultural Area	0.051	0.136	44,406
log(deposits)	15.693	1.809	44,406
log(loans)	15.459	2.112	44,406
(deposits - loans) / assets	0.811	1.977	44,406
Non-agricultural loans / total loans	0.690	0.275	44,406
Bank credit participation	0.056	0.058	26,897
outcome variables at loan-level			
log(loan)			
All sectors	10.374	1.777	2,795,805
All sectors - multi-lender firms	10.680	1.843	1,646,097
Agriculture	11.206	2.055	12,588
Manufacturing	10.939	1.933	581,003
Services	10.208	1.684	2,057,719
Other	10.446	1.911	130,985
outcome variables at firm-level:			
log employment			
All sectors	2.067	1.467	1,730,753
Agriculture	2.790	1.674	6,188
Manufacturing	2.665	1.445	303,871
Services	1.879	1.402	1,318,234
Other	2.761	1.665	84,328
log wage bill			
All sectors	8.387	1.722	1,730,753
Agriculture	8.966	1.871	6,188
Manufacturing	9.145	1.710	303,871
Services	8.160	1.637	1,318,234
Other	9.148	1.983	84,328

Notes: All variables are winsorized at 1% in each tail. See section IV for a detailed description of data sources.

Table II: Soy Technical Change and Agricultural Census Outcomes
GE Soy Adoption, Agricultural Productivity, Profits and Investment per hectare

outcome:	$\frac{\text{GE Soy Area}}{\text{Agricultural Area}}$		Δ Agricultural Productivity		Δ Profits per he (%)		Δ Investment per he (%)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \log A^{soy}$	0.039***	0.033***	0.119***	0.116***	0.259***	0.229***	0.181***	0.214***
	[0.003]	[0.003]	[0.028]	[0.031]	[0.071]	[0.079]	[0.044]	[0.048]
rural pop$_{t=1991}$	y	y	y	y	y	y	y	y
AMC controls$_{t=1991}$		y		y		y		y
Observations	3,020	3,020	3,020	3,020	3,020	3,020	3,020	3,020
R-squared	0.082	0.152	0.009	0.011	0.004	0.014	0.014	

Notes: The outcomes in this table are sourced from the Agricultural Censuses of 1996 and 2006. We thus estimate a first-difference version of equation (7):

$$\Delta y_j = \Delta\alpha + \beta\Delta\log(A_j^{soy}) + \Delta\varepsilon_j$$

where the outcome of interest, Δy_j is the change in outcome variables between the last two census years and $\Delta\log(A_j^{soy}) = \log(A_j^{soy,HIGH}) - \log(A_j^{soy,LOW})$. Robust standard errors reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The variable rural pop is the share of rural adult population in an AMC according to the 1991 Population Census. AMC controls include: income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time.

Table III: Local Effects of Soy Technical Change
Soy Area Share, Deposits, Lending and Capital Export

outcome:	$\frac{\text{Soy Area}_t}{\text{Agri Area}_{t=1996}}$		log(deposits)		log(loans)		$\frac{deposits-loans}{assets}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log A^{soy}	0.021***	0.017***	0.060***	0.070***	-0.077***	-0.061**	0.305***	0.297***
	[0.002]	[0.002]	[0.016]	[0.016]	[0.029]	[0.029]	[0.062]	[0.065]
AMC fe	y	y	y	y	y	y	y	y
year fe	y	y	y	y	y	y	y	y
rural pop$_{t=1991}$ × year fe	y	y	y	y	y	y	y	y
AMC controls$_{t=1991}$ × year fe		y		y		y		y
Observations	44,406	44,406	44,406	44,406	44,406	44,406	44,406	44,406
R-squared	0.958	0.959	0.975	0.976	0.951	0.951	0.711	0.713
N clusters	3145	3145	3145	3145	3145	3145	3145	3145

Notes: Standard errors clustered at AMC level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The variable rural pop is the share of rural adult population in an AMC according to the 1991 Population Census. AMC controls include: income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time.

Table IV: Capital Reallocation Across Municipalities
Lending and Non-Agricultural Lending Share

outcome:	log(loans)			$\frac{\text{non-agricultural loans}}{\text{total loans}}$		
sample:	all	soy region	non-soy region	all	soy region	non-soy region
	(1)	(2)	(3)	(4)	(5)	(6)
$MunicipalityExposure_{dt}$	0.283***	0.054	0.580***	0.090***	0.046*	0.139***
	[0.090]	[0.124]	[0.131]	[0.016]	[0.024]	[0.023]
AMC fe	y	y	y	y	y	y
year fe	y	y	y	y	y	y
rural pop$_{t=1991}$ × year fe	y	y	y	y	y	y
AMC controls$_{t=1991}$ × year fe	y	y	y	y	y	y
Observations	44,406	22,550	21,856	44,406	22,550	21,856
R-squared	0.952	0.949	0.953	0.843	0.846	0.779
N clusters	3145	1565	1580	3145	1565	1580

Notes: Standard errors clustered at AMC level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.The variable rural pop is the share of rural adult population in an AMC according to the 1991 Population Census. AMC controls include: income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time.

Table V: Propagation to Non-Soy Producing Regions: Access to Bank Credit
Overall and by Firm Size Category

outcome:	Bank Credit Participation		
sample:	all firms	micro and small	medium and large
	(1)	(2)	(3)
$MunicipalityExposure_{dt}$	0.012	0.012	-0.004
	[0.006]**	[0.006]**	[0.024]
AMC fe	y	y	y
year fe	y	y	y
rural pop $_{t=1991}\times$ year fe	y	y	y
AMC controls $_{t=1991}\times$ year fe	y	y	y
Observations	26,897	26,801	25,853
R-squared	0.474	0.455	0.556
N clusters	1928	1928	1928

Notes: Standard errors clustered at AMC level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The variable rural pop is the share of rural adult population in an AMC according to the 1991 Population Census. AMC controls include: income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time.

TABLE VI: BANK DEPOSITS AND BANK EXPOSURE

outcome:	log deposits			
	(1)	(2)	(3)	(4)
$BankExposure_{bt}$	1.427**	1.664***	1.580**	1.750**
	[0.587]	[0.562]	[0.761]	[0.688]
Log Assets$_{b,t=0} \times t$		-0.012		-0.010
		[0.010]		[0.012]
Deposits/Assets$_{b,t=0} \times t$			-0.085	-0.068
			[0.140]	[0.151]
bank fe	y	y	y	y
year fe	y	y	y	y
Observations	1,052	1,052	1,052	1,052
R-squared	0.913	0.913	0.913	0.913
N clusters	121	121	121	121

Notes: Standard errors clustered at bank level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Regressions are weighted by total bank assets in 1996. Bank controls are observed in 1996 (source: ESTBAN) and interacted with linear time trends.

Table VII: The Effect of Bank Exposure on Loans
Loan Value

outcome:	log loan			
			multi-lender	
	(1)	(2)	(3)	(4)
$BankExposure_{bt}$	0.245	0.277	0.271	0.211
	[0.118]**	[0.106]***	[0.107]**	[0.093]**
fixed effects:				
firm	y	y	y	y
year	y	y	y	y
bank	y	y	y	y
AMC × year		y	y	y
Sector × year		y	y	y
firm × year				y
Observations	2,795,805	2,795,805	1,646,097	1,646,097
R-squared	0.545	0.550	0.529	0.658
N clusters	115	115	115	115

Notes: Standard errors clustered at bank level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time. Sector dummies correspond to the 87 2-digit sectors according to the Brazilian CNAE 2.0 classification.

Table VIII: The Effect of Bank Exposure on Loans by Sector
Loan Value

outcome:	log loan			
	Agriculture (1)	Manufacturing (2)	Services (3)	Other (4)
$BankExposure_{bt}$	0.125	0.304	0.266	0.228
	[0.211]	[0.158]*	[0.096]***	[0.177]
fixed effects:				
firm	y	y	y	y
year	y	y	y	y
bank	y	y	y	y
AMC × year	y	y	y	y
Sector × year	y	y	y	y
Observations	12,588	581,003	2,057,719	130,985
R-squared	0.685	0.571	0.527	0.595
N clusters	73	113	115	95

Notes: Standard errors clustered at bank level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time. Sector dummies correspond to the 87 2-digit sectors according to the Brazilian CNAE 2.0 classification.

Table IX: The Effect of Firm Exposure on Firm-level Outcomes
Employment and Wage Bill

outcome:	log employment		log wage bill	
	(1)	(2)	(3)	(4)
$FirmExposure_{it}$	0.281	0.165	0.437	0.226
	[0.044]***	[0.040]***	[0.055]***	[0.043]***
fixed effects:				
firm	y	y	y	y
year	y	y	y	y
AMC × year		y		y
Sector × year		y		y
Observations	1,730,753	1,730,753	1,730,753	1,730,753
R-squared	0.882	0.885	0.902	0.905
N clusters	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. AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time. Sector dummies correspond to the 87 2-digit sectors according to the Brazilian CNAE 2.0 classification.

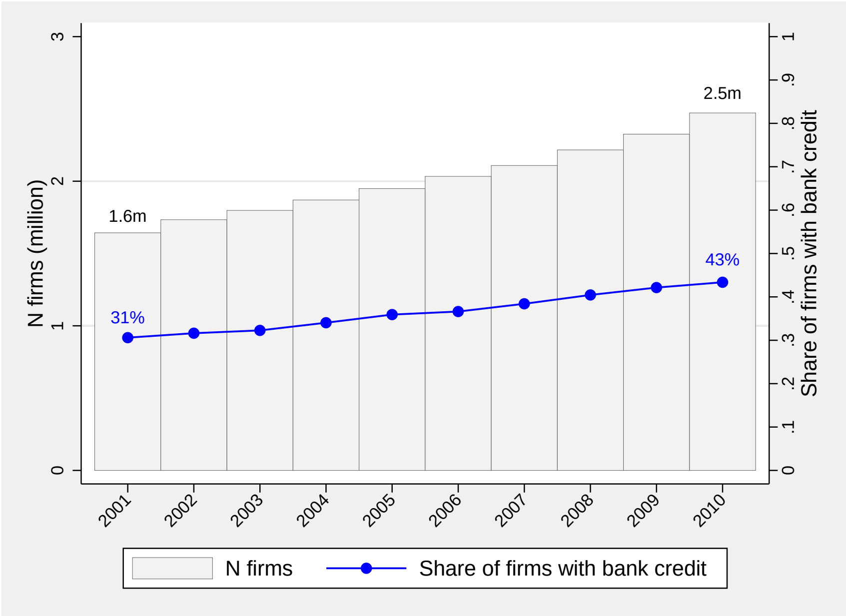
Table X: The Effect of Firm Exposure on Firm-level Outcomes - By Sector
Employment and Wage Bill

outcome: indep var: $FirmExposure_{it}$	log employment (1)	log wage bill (2)
Agriculture	0.253	0.282
	[0.149]*	[0.139]**
Observations	6,188	6,188
R-squared	0.935	0.945
N clusters	55	55
Manufacturing	0.202	0.309
	[0.050]***	[0.056]***
Observations	303,871	303,871
R-squared	0.890	0.913
N clusters	103	103
Services	0.162	0.211
	[0.039]***	[0.040]***
Observations	1,318,234	1,318,234
R-squared	0.875	0.896
N clusters	112	112
Other	0.024	0.108
	[0.064]	[0.085]
Observations	84,328	84,328
R-squared	0.939	0.948
N clusters	79	79
fixed effects in all specifications		
firm	y	y
year	y	y
AMC × year	y	y
Sector × year	y	y

Notes: Standard errors clustered at main lender level reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. AMC stands for Minimum Comparable Area (*Área Mínima Comparável*). AMCs are composed by one or more municipalities and are defined by the Brazilian Statistical Institute (IBGE) as geographical units of observation that can be compared over time. Sector dummies correspond to the 87 2-digit sectors according to the Brazilian CNAE 2.0 classification.

Appendix

Figure A1: Share of Firms with Bank Credit
Brazil: 2001-2010



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 with a financial institution of at least 5,000 1997 BRL.