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Abstract

Using a heterogeneous agent model with incomplete markets and entrepreneurship, I show that development banks can generate significant and positive impacts in an economy if they target the infrastructure sector and are funded through low distortionary taxes. Calibrating the model for the Brazilian economy, I assess that a better credit policy by the Brazilian Development Bank (BNDES) can generate a welfare gain around 10%. However, with the current format, the subsidy policies in Brazil are, at best, useless to foster development, besides transferring welfare from the poor to the rich.

Keywords: Development banks, Financial Frictions, Entrepreneurship, Subsidies

JELs: E60, G18, O11

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1 Introduction

Development banks around the globe were created for different purposes (see De Luna-Martínez and Vicente (2012) for a survey with 90 development banks). However, development banks have the same goal, which is to achieve some kind of second best in an economy with any market failure. Furthermore, many of them relies on government funds to operate, what naturally raises the question if they are, indeed, being helpful to the society and how policy makers can make a better use of this policy tool.

In this paper, I assess the effects of government intervention in the credit market, by including a development bank in a heterogeneous-agent model with incomplete markets and entrepreneurship. The development bank (DB) acts lending money to entrepreneurs at an interest rate lower than private banks' rates, and can target a specific set of firms that generates positive externalities (infrastructure, for example). This government policy generates a general equilibrium effect, changing prices and occupational choices, which may turn the outcomes non-trivial.

Several studies investigate the relationship between financial frictions and occupational choice to analyse aggregate and redistributive impacts of those frictions using models of heterogeneous agents [Antunes et al. (2008*a*,*b*, 2013); Antunes and Cavalcanti (2007); Banerjee and Newman (1993); Boháček (2007); Merlin and Teles (2014)]. Most of these studies finds not only relevant distributive effects, but also strong aggregate negative outcomes from financial constraints. Moreover, Ranasinghe et al. (2016), using firm level cross-country micro data find that the lack of access to finance is a major obstacle to business operation in poor and developing countries. However, few works have tried to study the effects of government policies in this framework. Buera et al. (2012), for instance, find that microfinance policies and credit programs targeted toward small businesses can have strong impacts on income distribution, due to significant general equilibrium effects on prices.

Closely related with this work, Antunes et al. (2015) find that credit subsidies have small power to foster GDP, and can actually reduce wages and increase inequality, if the subsidies are funded by payroll taxes. The authors also find that fighting structural problems in the credit market (creditor protection, asymmetric information and intermediation costs) would be much more effective than subsidize credit. Buera et al. (2013) also do not find theoretical support to subsidies. Assuming that the idiosyncratic productivity process of firms is mean-reversal and subsidies are permanent, they show that, even if the most productive entrepreneurs were perfectly targeted at some point of the time, the overall result would be an economic miracle followed by a disaster, once firms' productivity reverts to the mean, but they keep receiving subsidies.

The empirical micro evidence on the effects of developing banks on firms' investment, employment

and output is not consensual. Eslava et al. (2012) find strong positive effects of long-term financing on firms' productivity, investment, output and employment in Colombia. On the other hand, Carvalho (2014) shows the unavoidable face of a government owned bank, which is the political influence over investments decisions, in this case by targeting subsidized loans to firms that have projects in strategic and politically attractive regions.

In this work, I build a heterogeneous agent model with incomplete markets, credit frictions and occupational choice, and with additional important features: i) the development bank can target infrastructure firms, generating positive externalities in other sectors; ii) there are self-employed agents in the model, which represent a large fraction of the working force in developing countries, besides being potential employers that can be targeted by a development bank; iii) tax system is realistic and the costs of the subsidies can be funded in different ways.

The model is calibrated and policy experiments are performed for Brazil, that has one of the largest development bank in the world, The Brazilian Development Bank (BNDES), responsible for more than a third of all credit to firms in Brazil.[1] The main finding is that subsidies can be welfare improving, thanks to externalities generated by infrastructure sector, often ignored by the literature. Using a correct targeting and subsidy policies, BNDES could generate welfare gains higher than 10% for the Brazilian economy, in the long-run. However, with the actual subsidy and lending policies, BNDES is, at best, being useless.

The rest of the article is divided into four sections. Section 2 provides a brief description of how BNDES acts in the Brazilian economy. Section 3 presents the environment of the theoretical model. In section 4 the calibration and assessment of the counterfactuals/policy experiments are presented. Finally, in section 5, some conclusions and policy implications are discussed.

2 BNDES - The Brazilian Development Bank

The Brazilian National Development Bank (BNDES) was created in 1952, with the single purpose to foster infrastructure investments through long-run financial support. In the following decades, the role of BNDES became (much) broader. Nowadays, the bank has presence in basically all sectors, regions, and offers subsidized credit to firms of all sizes and for different purposes (machinery acquisition, working capital, project finance, exports, credit card, micro-finance, and others), having the infrastructure share over total BNDES' disbursements shrank to less than 40%.

In 1995, the central government created the TJLP (long-run interest rate, in free translation), a subsidized interest rate which is the basic cost of financing of BNDES. This rate was determined by the

[1] Canada, Germany, China and Japan also have large development banks, in absolute terms, but their relative importance is smaller, since these countries have a credit market with less frictions, compared to Brazil.

National Monetary Council and, during 2007-2014, was 460 bps lower than the short-term interest rate controlled by the Brazilian Central Bank, on average. In 2017, the Brazilian Central Bank and the Ministry of Finance announced that in 2018 the TJLP would give place to the called TLP (long-run rate, in free translation), which will converge, until 2023, to the 5-year government bond real yield plus CPI inflation, putting an end in this implicit subsidy. Regarding the funding, BNDES' funds come from a specific tax fund[2] (27% of the liabilities in 2016) and, specially after 2010, huge amounts of transfers from the Treasury (50% of the liabilities in 2016).

The relative size of BNDES in the Brazilian credit market is impressive: from 2007 to 2016, BNDES was responsible for roughly a third of the overall outstanding credit to non-financial corporations. Most of this amount is targeted to large companies. In the last 20 years, the share of annual disbursements targeted to large companies fluctuates around 75%. In the last 10 years, half of the total disbursements was targeted to 250 corporations, and 22% goes to only 10 firms each year, on average. This extremely high lending concentration, focused on firms that, in most cases, can issue bonds/notes puts in question if the subsidized credit is being correctly targeted. In fact, the mentioned facts probably would not be a great problem if the resources were targeted to high productivity large firms. More recently, however, some of these few large firms, labelled by the Brazilian government as 'National Champions', faced serious problems, and many of them have even bankrupted or were involved in enormous corruption schemes[3]. Following this, the BNDES' delinquency rate, usually below 0.1% (since BNDES lends money mainly to large companies, the risk is very low, even compared with DBs from developed countries), rose to more than 2% in 2016.

Actually, some empirical works have already shown that, albeit full of good intentions, the BNDES' subsidized credit policy is, perhaps, not fostering investment and development as intended. Carvalho (2014), using employment data from manufacturing plants in Brazil, finds that BNDES' credit and, consequently, employment level, are shifted from politically unattractive regions to attractive ones, specially near re-election years. He finds evidence that suggests that politicians influence elections through subsidized lending. Cavalcanti and Vaz (2017) use Brazilian data from small and medium firms and find that BNDES' subsidized credit increases their labor productivity and TFP by something around 10%, but only if the access to subsidies is permanent. Ottaviano and Sousa (2007), also using micro-data, found positive effects of BNDES on productivity, but only for large/high quality projects and with a lag of three years.

[2]The fund (Fundo de Amparo do Trabalhador - FAT) is basically composed by: 0.6% of firms' gross revenues; 1% of the payroll of non-profitable entities; and 1.65% over the imports of goods and services. 40% of this fund goes to BNDES and the remaining composes the unemployment insurance funding.

[3]Just as an exemplification, the former president of JBS, one of the largest food companies in the world, in a recent plea deal, stated that paid up to 4% of the loan contract value for each person involved in the scheme. Source(in Portuguese): http://g1.globo.com/politica/noticia/em-novo-anexo-joesley-diz-que-pediu-a-politicos-que-interferissem-no-bndes.ghtml

Therefore, since BNDES is almost a Frankenstein's monster, a huge and out of control machine, it is extremely important to understand how to control and use it in benefit of the society. In the next sections, I build model able to comprise some of the aforementioned facts, calibrate it to the Brazilian economy, and perform some policy counterfactuals to discover how it is possible to achieve best results for the population.

3 Model

The model follows some aspects of Antunes et al. (2015), Buera et al. (2013) and Merlin and Teles (2014). In short, the model is represented by an unit mass of agents, ex-ante identical, who differ each other by their actual business "idea", i.e., their productivity while managing a firm.[4] Each period, based on their savings and idea, agents will choose between search for a job, be a self-employed (SE) or an employer. The employers can choose to operate in different sectors, infrastructure (I) or non-infrastructure (NI), which differ each other by their capital intensity and productivity. The infrastructure capital generates externalities on other sectors, enhancing their overall productivity. Agents can use their savings as equity, if they decide to be entrepreneurs. Moreover, savings may be transferred to firms through a private banking sector, which charges a spread to lend money to entrepreneurs, subject to a collateral constraint. In addition to private banks, there is a development bank, owned by the government. The DB can lend money to firms at subsidized rates, financed by several types of distortionary taxes. The economy is closed, then real interest rate and wages are endogenously determined by the supply and demand of assets and labor, respectively.

3.1 Households

Households inelastically supplies one unit of labor and maximize their intertemporal utility, given by

$$\mathbb{E}_{i0}\left[\sum_{t=0}^{\infty}\beta^t U(c_{it})\right] \;=\; \mathbb{E}_{i0}\left[\sum_{t=0}^{\infty}\beta^t\left(\frac{c_{it}^{1-\gamma}}{1-\gamma}\right)\right] \tag{1}$$

where β is the intertemporal discount rate, $c_{it} \in C \subset \mathbb{R}_+$ refers to consumption of agent i at time t, and γ is the relative risk aversion coefficient.

[4] This approach is similar to studies in which "managerial skill" dictates productivity, such as in Antunes and Cavalcanti (2007); Lucas (1978); Rauch (1991), with the difference that it allows for limited persistence in idiosyncratic productivity process, which, in my framework with infinitely-lived agents, is necessary to generate capital misallocation.

The budget constraint of households is given by

$$c_{it}(1+\tau^C) + s_{it+1} \leq \omega_{it} + (1 + r_t(1-\tau^S))s_{it} + T_t + B_t \tag{2}$$

where τ^C is a consumption tax rate; $s_{it} \in A \subset \mathbb{R}_+$ are savings, which can be used as equity, $e_{it} \in A \subset \mathbb{R}_+$, if agents become an entrepreneur; r_t is the real interest rate, which return is taxed by τ^S; T_t are lump-sum transfers from the government; B_t are banks profits/costs, equally distributed between all agents; and ω_{it} is the labor/business related income. More precisely,

$$\omega_{it} = \begin{cases} w_t, & \text{if worker (W)} \\ \Pi^{SE}(z_{it}, s_{it}), & \text{if self-employed (SE)} \\ (1-\tau^E)\Pi^j(z_{it}, s_{it}), & \text{if employer in the sector } j = (NI, I) \\ 0, & \text{if unemployed (U)} \end{cases} \tag{3}$$

where w_t is the equilibrium wage; $\Pi^{SE}(z_{it}, s_{it})$ is the profit function of self-employed; $\Pi^j(z_{it}, s_{it})$ is the profit of the employer in sector $j \in (NI, I)$, which is a function of the idea (z_{it}) and savings allocated in agent's i firm; and τ^E is a tax rate on profits[5]. The individual idea process, $z \in Z$, follows a log-normal distribution, $\ln z_{it} \sim N(0, \sigma_Z^2/(1-\rho^2))$, with autocorrelation ρ. Process persistence allows agents to stay in the same occupation for a longer time, but not indefinitely.

Employment is not certain, and households who choose to be workers face an exogenous probability, P^W, of finding/keeping a job[6]. I set the timing such that agents choose their next period savings (s_{it+1}) before know if they will have a job or not, then they will take into account the expected utility when applying for a vacancy.

3.2 Financial Intermediation Sector

Private banks obtain resources from households' savings, which remuneration is r_t. Banks lend to entrepreneurs charging a spread, which is decomposed into taxes, τ^B, and costs/profits, χ. Hence, the lending interest rate is $r_t^L = r_t + \chi + \tau^B$. As stated in (2), the costs and profits of the private banks are evenly distributed across all individuals.

The development bank is owned by the government, that competes with private banks to obtain resources in the financial market remunerating at the real interest rate, r_t. Using public resources, the

[5] I assume that self-employed does not pay tax on profits, since they usually are part of the informal workforce or pay very low taxes, in comparison to other entrepreneurs.

[6] For sake of simplicity, this probability is independent of any other variable, and is the same for all agents, which implies that the probability of finding a job is equal to the probability of keeping a job in the next period.

development bank lend money to entrepreneurs at a subsidized interest rate, $r_t^S = r_t - \zeta$, where ζ is the (net) subsidy rate.[7] Another policy variable of the development bank is the probability of approving a loan to each type of entrepreneur, P^j, $\forall j \in (SE, NI, I)$. Furthermore, in order to apply for a loan, entrepreneurs have to incur a fixed cost, κ. This cost tries to capture not only the monetary costs of the application, but also possible costs related to political connections or even corruption schemes. This cost is not transferable to any other agent in the economy and has to be paid even if the loan is not approved by the DB.

3.3 Entrepreneurs

Entrepreneurs can either be a self-employed or an employer, and in this latter case, they can choose to operate in different sectors. The sectors can differ each other by the capital intensity and by the fact that some activities may generate externalities on the rest of the economy but, for tractability, I assume that the output from each sector is homogeneous.[8] In the counterfactual exercises, I consider that employers can operate in two sectors: non-infrastructure and infrastructure, but a more disaggregated setting can be used.

At the beginning of each period, agents who choose to become entrepreneurs have to decide the total physical capital demand and, if employers, the labor demand, as well. They can use their own assets or loans, from commercial or development banks, to acquire physical capital. To obtain a loan, they face a credit constraint, proportional to their wealth.

The production technology function takes the form of a traditional Cobb-Doublas production function with decreasing returns to scale. Thus, the entrepreneur i in the period t faces the following problem:

$$\begin{cases} \max_{d^p, d^g, e} \quad \bar{A} A^{SE} z_{it} (k_{it}^{\alpha^{SE}})^{1-\nu} - r_t^L d_{it}^p & \\ -r_t^S d_{it}^g - \delta k_{it} - r_t(1-\tau^S) e_{it} - \mathbb{1}_{DB}\kappa, & \text{if self-employed} \\ \max_{l, d^p, d^g, e} \quad \bar{A} A^{NI} z_{it} (k_{it}^{\alpha^{NI}} l_{it}^{1-\alpha^{NI}})^{1-\nu} - (1+\tau^L) w_t l_{it} & \\ -r_t^L d_{it}^p - r_t^S d_{it}^g - \delta k_{it} - r_t(1-\tau^S) e_{it} - \mathbb{1}_{DB}\kappa, & \text{if employer in NI sector} \\ max_{l, d^p, d^g, e} \quad A^I z_{it} (k_{it}^{\alpha^I} l_{it}^{1-\alpha^I})^{1-\nu} - (1+\tau^L) w_t l_{it} & \\ -r_t^L d_{it}^p - r_t^S d_{it}^g - \delta k_{it} - r_t(1-\tau^S) e_{it} - \mathbb{1}_{DB}\kappa, & \text{if employer in I sector} \end{cases} \tag{4}$$

[7] Note that I am not including cost/profits neither taxes in the lending interest rate from development banks. Since DBs usually do not have many branches, hires few employees compared with private banks, and their profits/taxes are,actually, government revenues, it will not make difference in the analysis and saves notation.

[8] If the output of each sector were considered different from each other, the utility function should have other goods or an aggregation sector must be included, requiring new prices, and then including more state variables in the model, becoming computationally more expensive.

subject to

$$\begin{aligned} k_{it} &= e_{it} + d^p_{it} + d^g_{it} \\ d^p_{it}(1 + r^L_t) + d^g_{it}(1 + r^S_t) &\leq s_{it}\phi \\ e_{it}, d^p_{it}, d^g_{it} &\geq 0 \\ e_{it} &\leq s_{it} \end{aligned} \tag{5}$$

where d^p_{it} is the total debt of the firm with private banks; d^g_{it} is the total debt of the firm with the development bank; $e_{it} \in [0, s_{it}]$ is the equity of the entrepreneur, which opportunity cost is $r_t(1 - \tau^S)$; δ is the depreciation rate of the physical capital; l_{it} is the quantity of labor hired; τ^L is a payroll tax rate; ν is the span of control parameter; α^j and A^j are, respectively, the capital share and the productivity in sector $j = (SE, NI, I)$; κ is the cost to apply for a subsidized loan; $\phi \geq 0$ imposes a collateral constraint (if $\phi = 0$ there is no credit in the economy and if $\phi = \infty$, entrepreneurs are not financially constrained for any $s_{it} > 0$); $\bar{A} = A_0 K_I^{\eta}$, with $K_I = \int\limits_{o(s,z)=I} k(s,z)d\lambda(s,z)$, is the productivity related to the overall infrastructure capital in the economy; $\eta \geq 0$ is the elasticity of the productivity with respect to infrastructure capital; and A_0 is a scale parameter.

As pointed above, not all entrepreneurs that apply for a loan with the development bank have their loans approved. Then, entrepreneurs that apply to these loans have to take into account the expected utility when applying for it, in a similar way that workers take into account the probability of not finding a job. I assume that, if the loan is not approved, entrepreneurs can use their own capital or borrow from private banks to operate their firms, but they cannot change sector or become workers.

3.4 Government

Government revenues comes from distortionary taxes, $\tau^C, \tau^S, \tau^E, \tau^L, \tau^B$. Expenditures are lump-sum transfers to all agents, T_t, and the cost of the subsidies. Furthermore, it is assumed that government's restriction is active in all periods, i.e., there is no public debt. Thus, the government's budget constraint is:

$$\begin{aligned} &\tau^L w_t \int l(s,z)d\lambda(s,z) + \tau^S r_t \int (s - e(s,z))d\lambda(s,z) + \tau^E \int\limits_{o(s,z)=I,NI} \Pi(s,z)d\lambda(s,z) \\ &+ \tau^B \int d^p(s,z)d\lambda(s,z) + \tau^C \int c(s,z)d\lambda(s,z) = T_t + \zeta \int d^g(s,z)d\lambda(s,z) \end{aligned} \tag{6}$$

where $\lambda(s,z)$ is the joint stationary distribution of agents over savings and ideas.

3.5 Equilibrium

Definition: A recursive competitive stationary equilibrium consists of a value function $V : A \times Z \to \mathbb{R}$; a decision sequence of the agents $S : A \times Z \to \mathbb{R}_+$, $C : A \times Z \to \mathbb{R}_+$; choices of entrepreneurs k, d^p, d^g, l; prices, r and w; and government's policy, T, such that:

1. Given prices, government's policies and subject to (2), (4), and (5), households maximize their individual problem, given by:

$$V(s,z) = \max_{c,s'} \left[\mathbb{E}[U(c)] + \beta \int_{z' \in Z} V(s',z')\Psi(z,z') \right] \tag{7}$$

2. The goods, labor and asset markets are in equilibrium:

$$\int c(s,z)d\lambda(s,z) + \int \kappa \mathbb{1}_{DB} d\lambda(s,z) + K' = \int y(s,z)d\lambda(s,z) + (1-\delta)K \tag{8}$$

$$P^W \int \mathbb{1}_W d\lambda(s,z) = \int l(s,z)d\lambda(s,z) \tag{9}$$

$$\int (s - e(s,z))d\lambda(s,z) = \int [d^p(s,z) + d^g(s,z)]d\lambda(s,z) \tag{10}$$

3. The government satisfies its budget constraint (6).

4. $\lambda(s,z)$ is an invariant distribution.

4 Calibration and Policy Experiments

I calibrate the model to match moments of the Brazilian economy[9]. It is assumed that a period of time is equivalent to a year. For some parameters, values can be obtained from reference studies or in data[10]. Other parameters have been endogenously calibrated to fit moments obtained in data. The calibrated values are shown in Table 1 and described below.

The discount rate, β, is calibrated in 0.939, to obtain, in equilibrium, an annual real interest rate equivalent to 4.5%.[11] Using data from Pesquisa Mensal do Emprego (PME), I target the occupational

[9] In the simulations, I choose the values 0 and 10000 for the minimum and maximum assets that can be chosen by agents, distributed exponentially over 1750 grid points. The idea process, $\Psi(z,z')$, is discretized by a Markov process with 10 states, using Tauchen (1986) procedure.

[10] Most of the variables covers the period of 2007-2014. Due to some discontinuity in credit related series, I could not use a larger span without make a few assumptions on how to extrapolate the data.

[11] The real interest rate was calculated using the SELIC, as the nominal interest rate, and the median of inflation expectations, available at the website of the Central Bank of Brazil.

Table 1: Calibration

Parameter	Value	Target
β	0.939	Real interest rate – 4.5% p.a. (BCB)
P^W	0.913	Unemployment - 6.8% (PME)
A^I	0.402	Share of employers in infrastructure sector - 9% (IBGE)
A^{SE}	0.655	Share of self-employed workers - 17.3% (PME)
ϕ	4.3	Credit to firms/GDP - 24% (BCB)
σ^z	0.0257	Gini of Employers Income - 0.49 (PME)
ν	0.039	Share of Employers - 4.2% (PME)
α^I	0.7	Share of the DB credit in infrastructure - 36% (BNDES)
κ	58	Share of the DB credit to firms - 33% (BCB)
Parameter	**Value**	**Source**
α^{NI},α^{SE}	1/3	Standard
A^{NI}	1	Normalization
τ^C	0.26	Azevedo et al. (2015)
τ^L	0.24	Azevedo et al. (2015)
τ^E	0.15	Azevedo et al. (2015)
τ^S	0.34	15% on nominal financial income
τ^B	0.0275	25% of the overall spread (BCB)
χ	0.0825	Spread on working capital and goods acquisition loans - 11% p.a. (BCB)
ζ	0.028	Average subsidy rate - 2.8% p.a. (BNDES)
P^{NI},P^{SE}	0.685	Share of approved direct loans for non-infrastructure projects (BNDES)
P^I	0.661	Share of approved direct loans for infrastructure projects (BNDES)
ρ	0.95	Monacelli et al. (2011); Ranasinghe et al. (2016)
δ	0.037	Morandi and Reis (2004)
γ	2	Standard
η	0.1	Calderón et al. (2015); Mussolini and Kanczuk (2011)
A_0	1.0381	Normalization - $\bar{A} = 1$ in steady-state

Notes: Occupational choice data are from Monthly Employment Survey (PME - Pesquisa Mensal do Emprego); interest rate and spreads are from Central Bank of Brazil (BCB - Banco Central do Brasil). The share of firms in infrastructure sector is taken from IBGE (Estatisticas do Cadastro Central de Empresas - 2012).

choice in the model. The probability of finding a job, P^W, is set to 0.913, to approximate the average rate of open unemployment of 6.8%.[12] The productivity of infrastructure firms relative to non-infrastructure firms (normalized in 1) is set to 0.402, to obtain a share of employers in infrastructure sector of 9%.[13] The relative productivity of self-employed is set to 0.655, to match the proportion of 17.3% of self-employed workers in equilibrium. The credit constraint parameter, ϕ, is set to 4.3, to obtain a credit to firms/GDP ratio of 24%. The standard deviation of the inovation of the log-normal process of idea is set to 0.0257, to obtain, in steady-state, an employer's income Gini index of 0.49. A value of 0.039 is set for ν, to obtain 4.2% of employers in the workforce. The capital-share in the infrastructure sector, α^I, is set to 0.7, to

[12]Permanent and military civil servants, as well as unpaid workers, are excluded in the analysis.

[13]I follow the definition used by BNDES to distinct the infrastructure sector from the others, in order to get consistency with their data. Basically the sectors considered as infrastructure are: electricity and gas, water and waste water, construction, transports and telecommunications. We also make an assumption that each agent can have only one firm when merging individual and firm datasets.

obtain a share of 35% of all subsidized credit going to infrastructure. To match the share of credit to firms intermediated by the DB, 33%, I set $\kappa = 58$.

The remaining parameters can be found in data or in the related literature. Capital-share of self-employed agents and non-infrastructure firms are set at 1/3. The productivity in the non-infrastructure sector is normalized to 1. Some tax rates, τ^C, τ^L, τ^E, are estimated by Azevedo et al. (2015). τ^S is obtained by applying the tax rate on financial nominal income to the real income.[14] τ^B and χ are obtained from Banking and Credit Report of 2010 (Central Bank of Brazil), which decomposes the banking spread in Brazil (11% per year for working capital and goods acquisition for firms), and finds that roughly 25% are due taxes, while the remaining are costs and profits. The development bank's policy variables (ζ, P^{SE}, P^{NI} and P^I) are approximated from BNDES' data and studies. From 2009 to 2014, BNDES charged an average spread of 1.8% above their subsidized funding cost, the TJLP. Since TJLP was, on average, 460 bps below the policy rate, I find a subsidized loan rate 2.8p.p. below the real interest rate. The probabilities of having a loan approved are calculated as the ratio of the value of approved loans over the value of the applications for loans. The autocorrelation of the log-normal idea process was set in 0.95, as in Monacelli et al. (2011); Ranasinghe et al. (2016). The depreciation rate, δ, is 0.037, a value found by Morandi and Reis (2004) for Brazil. The relative risk aversion parameter, γ, is aligned with the literature, that usually considers 1.5 or 2. Finally, the elasticity of the productivity with respect to the infrastructure capital, η, is set to 0.1, as estimated by Calderón et al. (2015) and Mussolini and Kanczuk (2011).

Table 2 shows the moments observed in data and those obtained in the model with the aforementioned calibration. Besides the targeted credit variables, the model captures very well the capital-to-output ratio, and the capital in infrastructure to output ratio. Regarding inequality measures, it is known that entrepreneurship is very important to obtain wealth concentration Cagetti et al. (2006); Quadrini (1999, 2000). Entrepreneurs save to expand their business, specially in an economy with high bank spreads and tight collateral constraints. Since in the model this is the main reason to save (precautionary savings plays a small role on aggregate savings, once government's transfers acts like a partial insurance against very low income/unemployment), the wealth Gini coefficient in the model is very high, above the value observed in data, but the model is able to capture the Top 1% wealth share adequately. The labor/profit income (ω_{it}) gini in the model is below the verified in the data, since the model abstracts for other types of heterogeneity for tractability. The labor income gini in the model is 0.21, but, again the model seems to follow the top 1% share very closely. Finally, since the model tries to capture the main sources of government funding, the tax burden obtained in the model is also in line with the data.

[14] I consider a tax rate of 15% on the nominal return, which is the rate considered for investments with 720 days or more, besides the fact that the average nominal interest rate was 10.2% in the period, and the real interest rate was 4.5%.

Table 2: Variables of Interest: Data x Model

Topic	Variable	Data	Model
Occupational Choice	Unemployed	6.8%	**6.8%**
	Self-Employed	17.3%	**17.4%**
	Workers	71.7%	**71.5%**
	Employers	4.2%	**4.2%**
	Employers in Infrastructure sector	0.38%	**0.38%**
Capital and Credit Variables	Credit to corporations/GDP	0.24	**0.24**
	Share of subsidized credit to corporations	0.33	**0.33**
	Share of infrastructure subsidized credit	0.36	**0.35**
	Capital to Output ratio	3.1	3.1
	Capital in Infrastructure to Output ratio	0.53	0.51
Inequality	Gini - Wealth	0.83	0.94
	Top Percentile Share - Wealth	0.48	0.50
	Gini - Employers	0.49	**0.49**
	Gini - Labor/Profits Income	0.48	0.21
	Top Percentile Share - Total Income	0.12	0.12
Other Indicators	Real Interest Rate	4.5%	**4.5%**
	Tax Burden/GDP	0.33	0.36

Sources: Wealth Gini and Top Percentile Wealth (Credit Suisse - Global Wealth Databook - 2016); K/Y (Morandi and Reis (2004), 2002 data); Capital in infrastructure to output ratio (McKinsey Global Institute - 2013); Labor/Profits Income Gini (PME/IBGE - 2007-2014); Top Percentile Income (National Household Sample Survey/IBGE - 2007-2014); Tax Burden (Ministry of Finance - 2007-2014). Targeted variables are in bold.

4.1 Occupational Choice

At the stationary equilibrium, for a given set of parameters, the proportion of agents in each of the occupational positions is constant. Figure 1 shows how agents' choices are made, based on their wealth and idea. Households without savings have no choice but to try a vacancy as a worker. However, with a small amount of wealth, agents with good ideas can start their own business, becoming self-employed. It is interesting to note that the least productive self-employed agents choose this position only to avoid a possible unemployment status, but if they have enough resources to smooth consumption, they will prefer to be a worker or employer instead. With a substantial amount of savings, be an employer becomes an option. Since the infrastructure sector is more capital intensive and have lower productivity, only very rich agents will become employers in this sector. Moreover, given the costs and uncertainty about of the application process, only extremely rich entrepreneurs will apply for subsidies. Eventually, at a certain level of savings, even the subsidies become useless, since in baseline calibration the cost of own capital is lower than the cost of borrowing from the development bank, i.e., $r(1-\tau^S) < r^S$.

4.2 Changes in Subsidy Rate

The subsidy rate is the policy variable that is currently most used by the Brazilian government, through the TJLP, that is set every quarter. I start the policy analysis by performing counterfactuals scenarios with

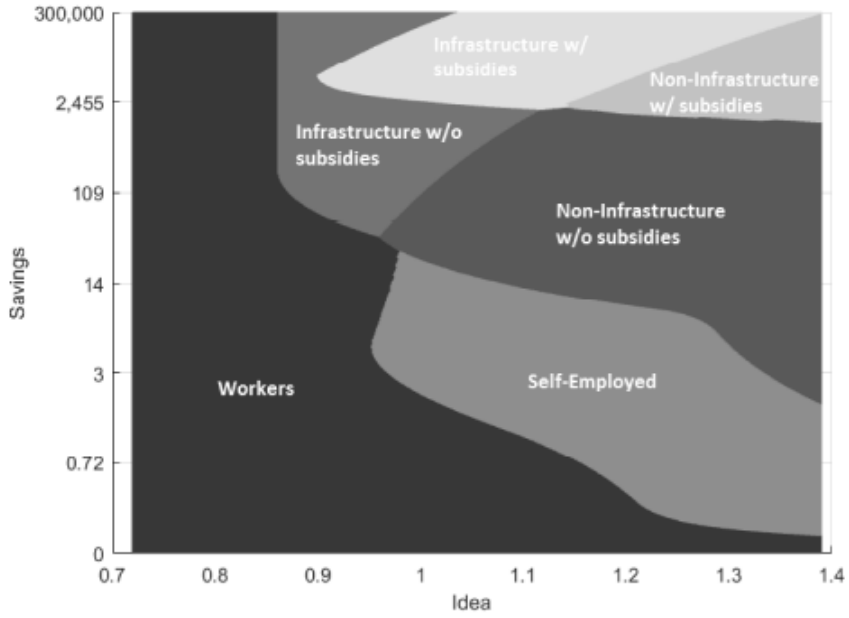

Figure 1: Occupational Choice

different subsidy rates, and considering three different structures: i) keeping all the other policy variables constant; ii) targeting only infrastructure sector; and iii) targeting only non-infrastructure sector.[15] Figure 2 shows the results of the simulations for selected variables of interest, and considering that the subsidies are funded by consumption taxes.

First point that can be noticed is that changes in the subsidy rate do not strongly affect outcome variables, with exception of credit-related ones. Furthermore, it is possible to see that with negative subsidy rates, i.e., when the DB charge a spread, the size of the DB is very small. Actually, if the subsidy rate achieve -0.05, agents do not want to pay the application cost, then the DB plays no role in the economy. I will discuss more deeply this scenario in section 4.6. When looking at positive subsidies, a higher subsidy rate increases the credit to firms to GDP ratio, pushing up the interest rates and then reducing the incentives to become an entrepreneur, since just a few rich employers have access to this cheaper credit. The effects on the other variables, however, will depend on how the DB is targeting its resources.

If the DB choose to target only the non-infrastructure sector, the effects of the subsidies are deleterious for the economy, reducing TFP, GDP, consumption, wages and welfare (measured by the equally distributed equivalent consumption, EDEC). The magnitude of the losses is not so expressive, but cannot be neglected. Considering the difference between the two extremes of subsidy rate (-0.049 to +0.077), the real interest rate is around 50 bps higher in the high subsidy scenario, the losses are close to 1%

[15] In cases ii) and iii), I consider that the probabilities to get a subsidized loan in other sectors is zero. I do not include a scenario targeting self-employed agents in this section, since they do not get subsidized credit due to prohibitive application costs.

for GDP, consumption, TFP and wages, and almost 2% in welfare (EDEC), in the new steady-state. The distortionary consumption tax rate needs to increase almost 1.3p.p. to maintain government's budget constraint, since the cost of the subsidies can achieve up to 0.8% of GDP, compared with 0.2% in the baseline specification. An important driver here is the shrinkage of the infrastructure sector, which suffers with higher interest rates.

Targeting the infrastructure sector would change the conclusions of the last paragraph substantially. The effects of the increase in interest rates and the subsequent reduction on entrepreneurship are more than offset by an increase in the infrastructure capital and overall productivity, $\bar{A}$. However, again the magnitude is not large, and wages, GDP and consumption are only 0.5% higher in a high subsidy scenario, compared to the case without subsidies. Looking at distributional (labor income Gini index) and welfare (EDEC) effects, it seems that there is an optimum subsidy rate, around 3%. A subsidy higher than this value acts like a transfer from the poor to the rich (infrastructure employers), barely changing the productivity.

Keeping the structure like as in the baseline, without target any sector, imply in results that are almost a mix of the other two scenarios. The dotted line in the first graph of the second line of Figure 2 shows how the share of infrastructure loans within the DB (right axis) changes with the subsidy rate. Without subsidies, infrastructure entrepreneurs do not apply for a loan with the DB, but increasing the subsidy rate to 3.5%, this share go up to almost 40%. Subsidies higher than 3.5% benefits the non-infrastructure sector more than the infrastructure sector, then reducing this share. The overall effect is ambiguous. GDP achieves a maximum when the subsidy rate is around 3.5%, at the point where the share of subsidized credit targeted to infrastructure is the highest. At this subsidy rate the labor income Gini index is the lowest, approximately 0.5p.p below the scenario without DB. However, this reduction in inequality arises from the fact that entrepreneurship is strongly reduced with the increase in the interest rate, reducing the profits of those who do not obtain a subsidized loan. Actually, the remaining indicators do not show that subsidies are good in this context. The blue circle highlight the baseline scenario, and shows that the observed subsidy rate has virtually no effect on productivity, wages, consumption and GDP, compared with a scenario without BNDES, while has a negative effect on welfare (-0.44%). The results of this scenario are qualitatively and quantitatively in line with the results obtained by Antunes et al. (2015), that also find small effects of the subsidies.

The results of these simulations imply that the problem is not the subsidy, but the actual (broad) structure of lending. If BNDES has maintained its single purpose to support only infrastructure investments, welfare would be 0.7% higher than in the baseline scenario.

4.3 Easing the access to subsidized credit

Bureaucracy, corruption and uncertainty are, obviously, variables that may affect investment decisions in an economy. In the model, the application cost and the probability of having a loan approved try to capture these factors. An application cost higher than zero and a probability of having a loan approved smaller than one implicitly target the subsidies to larger firms. A small entrepreneur, even if highly productive, will not try to obtain credit with the development bank if it is costly or risky.

Figure 3 shows the results of the simulations altering the probabilities of having the loan approved. Differently from changes in the subsidy rate, these probabilities seem to have stronger effects on the economy. With a probability of approval lower than 50%, the subsidized credit is almost not attractive for entrepreneurs. Hence, with a share of subsidized credit close to zero, the results of such scenario are very similar to those presented in Figure 2 with negative subsidy rate.

On the other hand, reducing the uncertainty sharply increases the demand for subsidies, specially for infrastructure entrepreneurs, that are more intensive in capital. As a result, the interest rate increases substantially, forcing smaller and less productive entrepreneurs to become workers or self-employed, what reduces labor income inequality. The effects on the remaining indicators will again depend on the targeting.

Focusing only on infrastructure firms, if the subsidized loan is certain ($P^I = 1$, $P^{SE} = P^{NI} = 0$), the changes in productivity (+8.8%), wages (+12.6%), consumption (+14.6%), GDP (+17.6%) and EDEC (+9.1%) are expressive in the new steady-state, compared with the baseline scenario. 92% of the credit is subsidized in this case, costing to the government 2.5% of GDP. However, since the productivity growth pushed up the tax base, a substantial reduction of the consumption tax rate would be possible. Obviously this scenario is not realistic, since the model abstracts from moral hazard and adverse selection issues, and implicitly assumes perfect enforcement on credit contracts. However, these simulations are an indicative that making the access to credit more predictable for infrastructure sector's entrepreneurs is very important and quantitatively relevant.

If the focus is on non-infrastructure projects, the effects are, again, not desirable. A strong increase in real interest rate, is heavily discouraging to entrepreneurs/self-employed without access to subsidized credit. If $P^{NI} = 1$ (and $P^I = P^{SE} = 0$), the subsidies for a few entrepreneurs would cost almost 4% of GDP, forcing an increase in the tax rate, and pushing the burden of the subsidies to the non benefited. The overall result is a 4% decrease in EDEC, even with an 3.2% increase in GDP, compared with the baseline probability scenario.

If there is no targeting, and $P^I = P^{NI} = P^{SE} = 1$, we have again an intermediate scenario. The distortions from the last paragraph are compensated by an increase in the infrastructure related productivity,

but only partially (less than 30% of the subsidies goes to infrastructure entrepreneurs). The overall effect is slightly better than in the non-infrastructure targeting scenario. If BNDES continues with its broad subsidy policy, it seems that a probability of approval of 90% would achieve a relatively good scenario, with a marginal improvement in aggregates, without imply welfare costs.

Another way to ease the access to BNDES' credit is by reducing the implicit application costs. The parameter κ in the model clearly tries to capture something that is not measurable, like bureaucracy costs, time to understand the BNDES' requirements, prepare the application, besides, in some cases, corruption schemes. However, the development bank can change this parameter implicitly, with better transparency, clearer rules, reduced bureaucracy and an improved governance, for example. Figure 4 shows the results of simulations altering this parameter.

A lower application cost democratize credit subsidies, allowing smaller firms to apply for it without incur significant losses. The effects of lower application costs are qualitatively similar to a higher probability of have the loan approved, but quantitatively slightly smaller. The main difference here is that, if application cost is very low for self-employed agents (upper x-axis), we obtain something similar to a 'microcredit' policy[16], and self-employed entrepreneurs are interested in subsidized loans. In the limit, if the costs are zero, a significant share of workers are willing to have their informal "own-business", almost doubling the share of self-employed in the economy. Moreover, some small employers will also prefer to work by their own and, since self-employed agents are less productive and do not pay taxes, overall results are lower wages, production and welfare (-10%). Labor income inequality is strongly reduced in this scenario, but the reason is due to a strong reduction of employers' profits. Another driving force here is that infrastructure sector is crowded out by the increase in interest rates, pushing productivity down even more.

4.4 Collateral Requirements

The collateral constraint imposes a credit friction in the model. It can make productive entrepreneurs financially restricted, since they cannot borrow as much as they want. In the baseline calibration, the parameter ϕ is set to 4.3, which means that banks can lend up to 81% of the physical capital to entrepreneurs.[17] Development banks can, however, have different collateral requirements than commercial

[16]The reader must be careful in comparing the results found here with Buera et al. (2012). They do not consider externalities, neither distinguish between employers and self-employed (less productive in my calibration). These two ingredients change the results significantly, both quantitatively and qualitatively. They also consider a different credit constraint, setting an upper bound. Here this limit does not exist, but diminishing returns are very strong for self-employed business, limiting, in practice, the loans.

[17]Actually, in the model, this value can be 100%, if the subsidies are great enough such that $r^S < r(1-\tau^S)$. In this case, rich entrepreneurs may prefer to borrow at the subsidized rate and do not use their own capital on their business. In fact, Lazzarini et al. (2015) find evidence which suggests that it may be happening.

banks. In Figure 5, results from simulations altering this parameter for BNDES are shown.

The mechanism is similar to previous simulations. More access to credit means higher interest rates, less employers, and then lower labor income inequality. If targeted to infrastructure the results are beneficial, as expected. When increasing ϕ to 50 (financing up to 98% of the capital), the increase in GDP is around 5%, but with a welfare gain of half of this magnitude. Without explicit targeting, the share of subsidized credit in infrastructure is decreasing with respect to ϕ, since loosening this constraint is more relevant for smaller (non-infrastructure) entrepreneurs. Given this, the results of targeting non-infrastructure firms or maintaining the actual targeting policy are similar, pushing down welfare (-4% and -3%, respectively).

4.5 Financing through more distortionary taxes

In the last years, BNDES' funding comes mainly through huge transfers from the Treasury. In previous simulations, I considered that the subsidies were financed by consumption taxes. Indeed, these taxes represents more than a half of the Brazilian tax burden, but there are also other sources of revenues. Since these transfers from the Treasury do not come from a specific tax, it is clear that other distortionary taxes could be reduced if such subsidies were eliminated. Table 3 shows the results of simulations of scenarios extinguishing BNDES, while reducing the tax rates to keep the government transfers constant (whenever possible).

Table 3: Financing BNDES with different types of taxes

Variable	Baseline	Lump-Sum	τ^C	τ^L	τ^E	τ^S	τ^B
Real Interest Rate	4.5%	4.1%	4.1%	3.9%	3.4%	3.0%	4.7%
Wages	100.00	99.98	99.98	105.91	111.82	101.98	103.97
% of Entrepreneurs	4.28	4.41	4.41	4.44	5.00	4.51	4.50
% of Infra. Entrepreneurs	0.38	0.44	0.43	0.44	0.70	0.46	0.50
% of Self-Employed	17.35	17.36	17.45	5.97	7.93	14.77	13.32
Credit to Firms/GDP	0.239	0.187	0.187	0.156	0.129	0.247	0.316
Gini Income	0.206	0.210	0.210	0.226	0.256	0.206	0.202
τ^i before	-	-	0.26	0.24	0.15	0.34	0.0275
τ^i after	-	-	0.257	0.172	0.00	0.00	0.00
Transfers	100.00	100.74	100.00	100.00	110.82	103.85	106.17
$\bar{A}$	100.00	99.94	99.94	100.73	105.70	100.57	101.19
TFP	100.00	100.17	100.15	103.14	105.93	102.38	104.26
Average Consumption	100.00	100.06	100.03	103.80	114.48	102.99	105.65
GDP	100.00	99.84	99.82	103.88	115.70	102.71	105.35
EDEC	100.00	100.55	100.44	100.86	109.65	103.50	106.34

The consumption tax almost does not distort the economy. The results from BNDES' shut down changing lump-sum taxes (increasing transfers by 0.74%) or consumption taxes (decreasing 0.3p.p. consumption tax rate) are very similar. As already explained in section 4.2, the baseline scenario and the sce-

nario without BNDES are not very different. In these low distortionary cases without BNDES, the real interest rate would fall 40bps, slightly increasing welfare (around 0.5%), entrepreneurship (+0.13p.p.) and labor income Gini index (+0.4p.p.), but barely changing wages, production, productivity and consumption. The results are, however, much stronger when considering other distortionary taxes.

When alleviating the payroll tax (specially important for the federal government budget), incentives to entrepreneurs are created, increasing the tax base and then allowing further reductions on the tax rate. In the new steady-state the payroll tax is almost 7p.p. lower. In this case, the labor demand strongly increases, pushing up wages by almost 6%, even with a greater labor supply (self-employed agents will prefer to search for a job). The infrastructure sector, more capital intensive, benefits from the interest rate fall, increasing the overall productivity even without subsidies. TFP grows more than 3%, while GDP and consumption almost 4%. The gains, however, are not even. Entrepreneurs from non-infrastructure sector are the most benefited, increasing labor income Gini index by 0.02.

The remaining tax rates are extremely distortionary. Their tax base are small, and the general equilibrium effect of reducing them actually increases government revenues. The results, therefore, cannot be interpreted as the BNDES effect, but as an indication that government should not use distortionary taxes, like τ^E, τ^S or τ^B, to fund public policies, and it is not different for credit subsidies. In fact, these results indicate that, the way how government fund its policies can be much more relevant than the distortion that it is trying to alleviate, since general equilibrium effects are not straightforward, specially in the long-run.

Until the financial crisis of 2008, BNDES' funds were basically obtained from payroll (only for non-profitable entities) and revenues (consumption) taxes, i.e., relatively low distortionary taxes. However, after 2010, huge amounts of transfers from the National Treasury were allocated to BNDES. Since Treasury's revenues come from different types of taxes, we would expect more distortions to maintain the credit subsidies. Fortunately, in the end of 2016, the Brazilian government took back R$100 billion[18] from BNDES to reduce the ascending public debt, and requested more R$130 billion in 2018. With this resources, the central government avoids to increase even more the Brazilian tax burden, and potentially generate more distortions.

4.6 Policy Experiment - BNDES Extinction

Table 3 have shown that the Brazilian economy without BNDES would have an overall welfare, measured by EDEC, around 0.5% higher than in the baseline scenario, if financed through consumption or lump-sum taxes. However, since it represents a steady-state comparison, we cannot state that policy makers

[18]This value corresponded around US$ 31 billion at the time, representing 18.7% of the overall liabilities of the BNDES with the Treasury, and 1.6% of GDP.

should, then, shut down BNDES. In order to evaluate a policy, we need to take a closer look at the transition dynamics between the two steady-states.

Figure 6 shows the transition dynamics of an unexpected extinction of BNDES for a set of variables of interest.[19] Following BNDES' extinction, the demand for loans is strongly affected, reducing the credit to firms/GDP ratio by more than 5p.p. and the equilibrium real interest rate by 50 basis points. This drop in the interest rate drives the changes in occupational choices, pushing up the share of entrepreneurs in the economy, specially those that rely more on capital (infrastructure sector), what increases aggregate productivity. It boosts labor demand, increasing wages by more than 0.5%. Besides this, there is reduction in the consumption tax rate, since subsidies were extinguished. The overall result is an increase of almost 0.6% in the aggregate consumption, and an instantaneous gain of almost 0.8% in welfare.

After the positive first impact, the adjustment to the new steady-state is slow and smooth, as the distribution of assets starts to change. Without cheap credit for big companies, agents do not have incentives to save too much, what reduces the aggregate capital until it achieves the new steady-state, almost 1.3% below the initial stock. As this process occur, the gains are gradually reduced. Although wages and GDP are lower in the new steady-state, welfare gains do not vanish, since w/τ^C increases and poor entrepreneurs are much better with lower interest rates.

Regarding the welfare gains, these are obviously not even. Although there are aggregate welfare gains during the transition and in the new steady-state, the distribution of the gains is very informative for policy makers. Figure 7 shows the distribution of the mean equivalent consumption gains just after BNDES' extinction. In the left graph, we can note that the rich are much worse without BNDES, since the interest rates drop reduces their capital income. This effect is much stronger for agents with good ideas, those who rely on subsidized loans. The losses can reach more than 40% for some entrepreneurs. The right graph take a closer look on agents that are better off without credit subsidies, i.e., the relatively poor. Agents with no savings and bad ideas gain almost 1% in mean equivalent consumption with the end of credit subsidies. On the other hand, talented poor agents gain not only from lower consumption taxes, but also from higher labor income (profits), since without BNDES interest rates would be lower. The welfare gains can achieve 2.5% for some agents.

[19] In the transition dynamics, I assume that the economy achieves the new steady-state after 100 years.

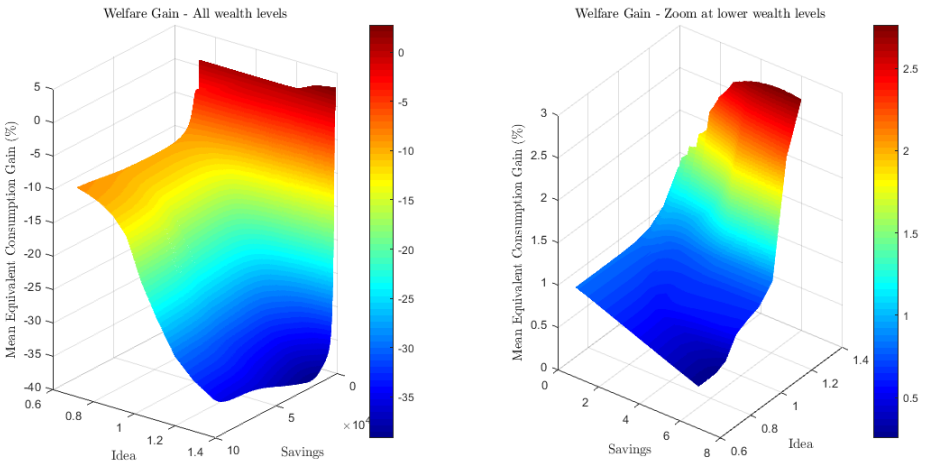

Figure 7: Mean equivalent consumption gain in a scenario without BNDES.

Note: The axis were rotated in the right graph for better visualization. For better understanding of the scale, the wage is 0.82 in the steady-state. In the right graph, almost 95% of the agents are being covered.

The results from this welfare analysis give support for those who state that BNDES is acting like a 'reversed Robin Hood', taking money/welfare from the poor and giving to the rich. With the actual structure, the analysis suggests that the potential benefits of the subsidized credit are being more than offset by distortions generated by it, with higher taxation, as well as changes in relative prices and occupational choices.

5 Final Remarks

In this study, a heterogeneous agent model with entrepreneurship was built to assess the effects of the subsidized credit in the Brazilian economy. Although responsible for roughly a third of the credit in Brazil, the BNDES, given its current targeting and subsidy policy, does not have significant effects on the aggregate variables of the Brazilian economy, since the small productivity gain from fostering infrastructure is partially offset by costs of the subsidies and by allocation distortions. The actual subsidy rate, per se, would not a big concern if the subsidies were correctly targeted. However, easing the access to a relatively cheaper credit seems to be the most effective policy to incentive infrastructure capital accumulation. I report that gains up to 15% and 10%, in production and welfare, respectively, are possible if the subsidies were correctly targeted and funded.[20] Currently, the subsidies are benefiting a lot the very rich, while punishing the vast majority of the population with higher taxes. Since BNDES' funding

[20]Since the Brazilian credit market is very concentrated and known for its stratospheric credit spreads, I believe that these gains should be interpreted as an upper bound for countries with less frictions.

may be extremely distortionary, the Brazilian central government took a big step when decided to gradually eliminate the subsidies. Now is BNDES' task to find a way to better target its loans, otherwise the infrastructure sector may suffer.

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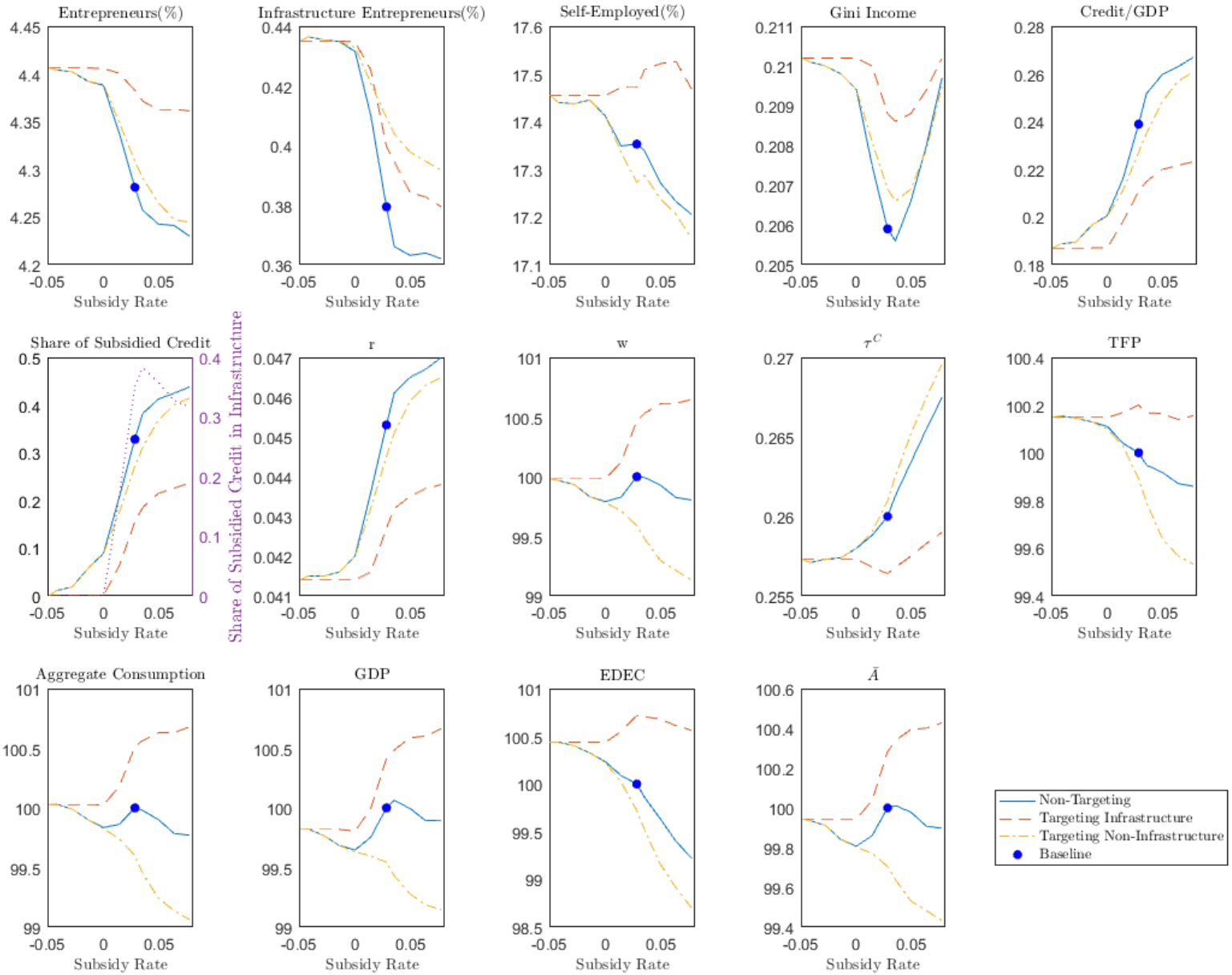

Figure 2: Simulations changing subsidy rate.

Notes: The first graph of the second row also includes a dotted line representing the share of subsidized credit in infrastructure on the right axis. The blue dot represents the baseline scenario.

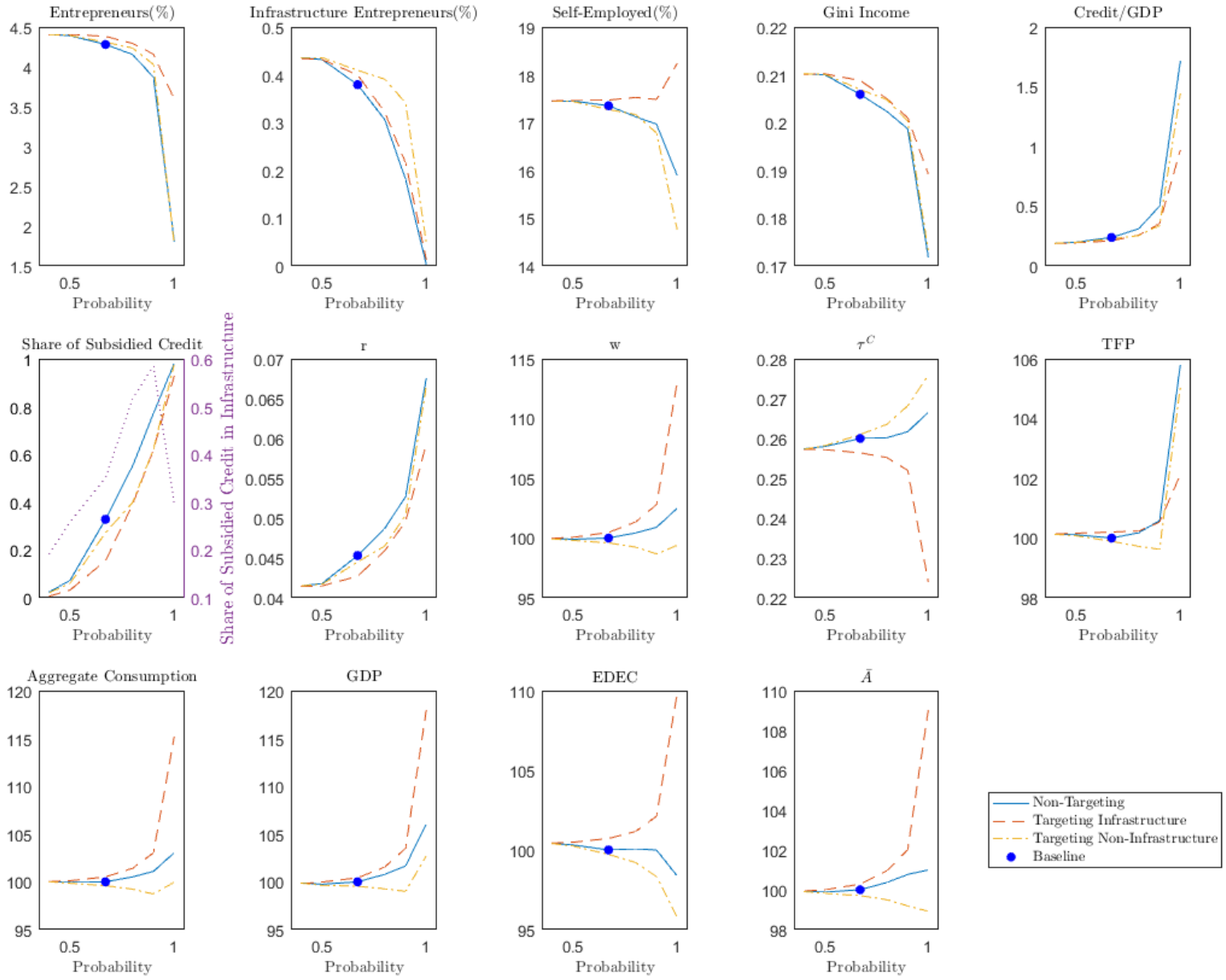

Figure 3: Simulations changing the probabilities of having the subsidized loan approved.

Notes: The first graph of the second row also includes a dotted line representing the share of subsidized credit in infrastructure on the right axis. The blue dot represents the baseline scenario.

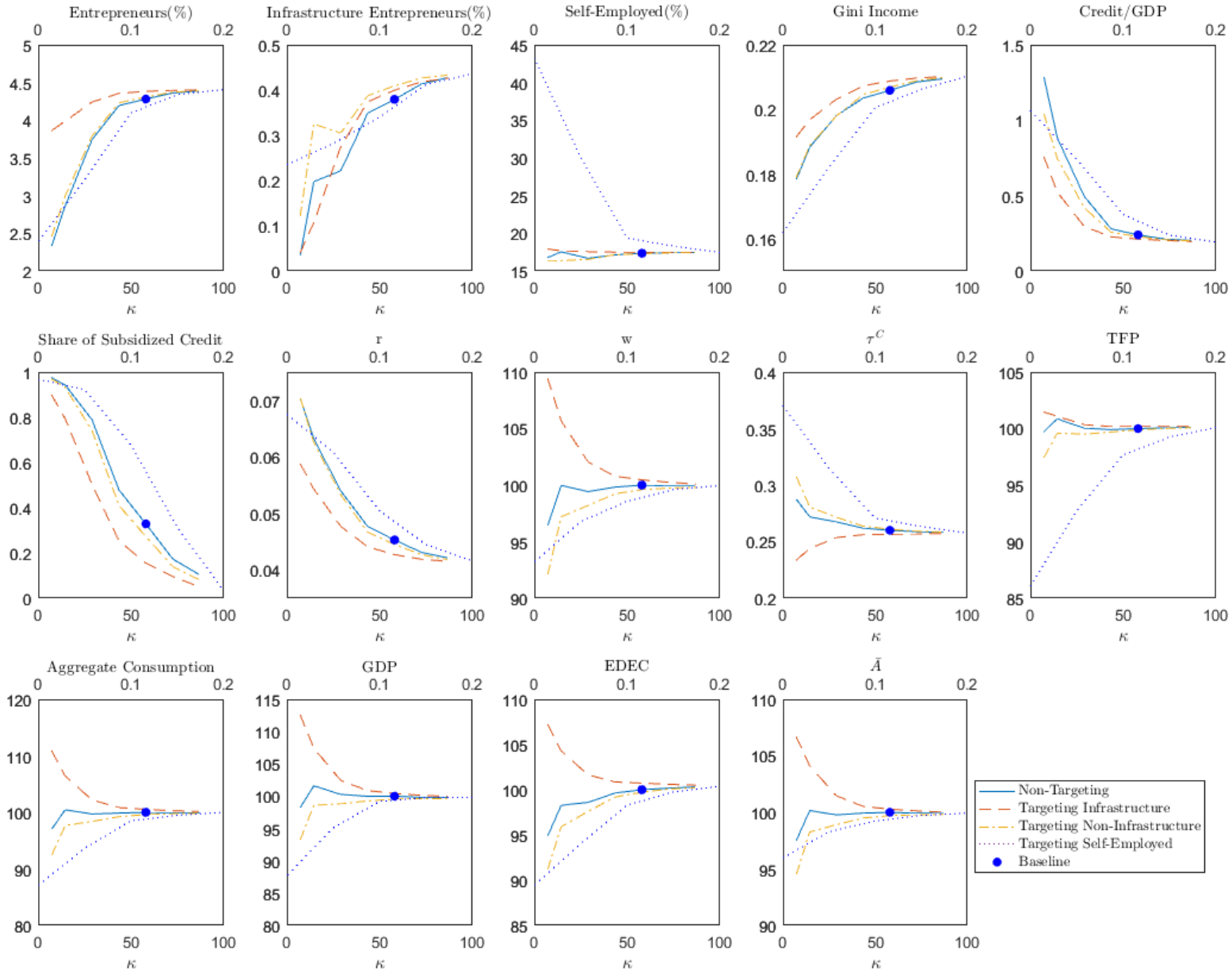

Figure 4: Simulations changing application costs.

Notes: The upper x-axis refers to applications costs in simulations targeting self-employed. The blue dot represents the baseline scenario.

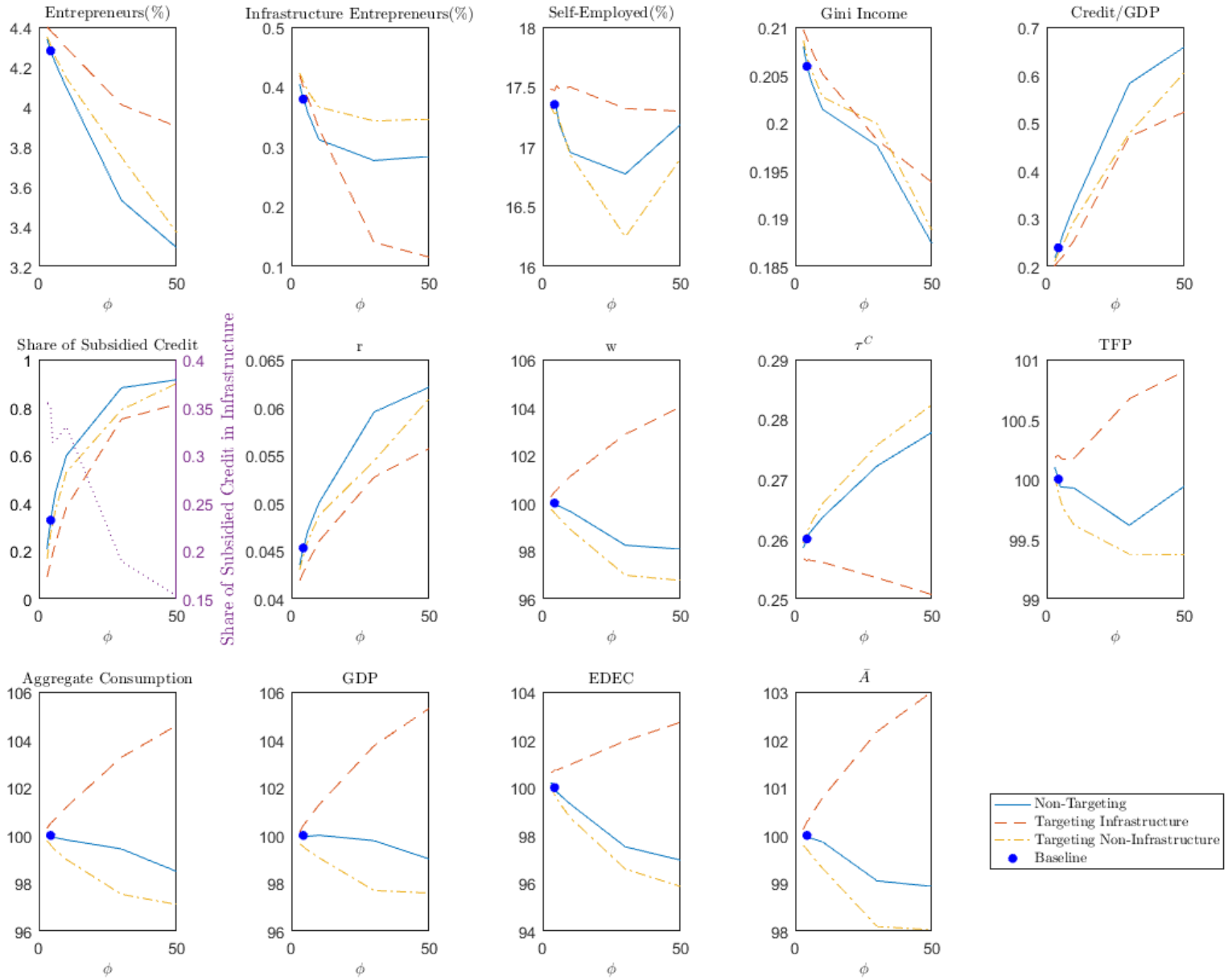

Figure 5: Simulations changing collateral requirements.

Note: The first graph of the second row also includes a dotted line representing the share of subsidized credit in infrastructure on the right axis. The blue dot represents the baseline scenario.

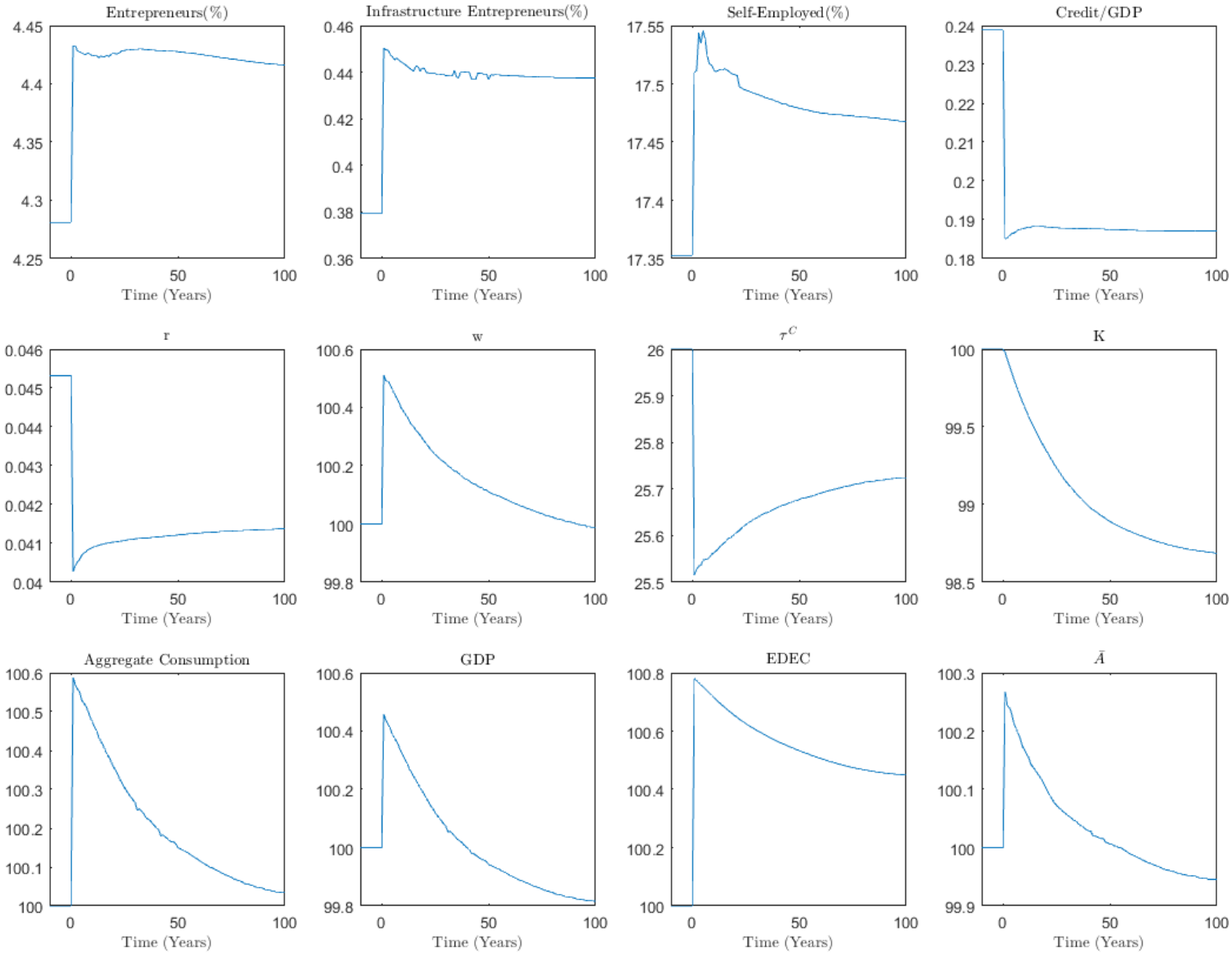

Figure 6: Transition Dynamics - BNDES Extinction