The Effects of Credit Subsidies on Development

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Abstract

This paper studies the effects of interest rate credit subsidies on economic development in a general equilibrium model with heterogeneous agents, occupational choice and financial frictions. There are two financial frictions: a cost to intermediate loans and a limited liability problem which maps into the degree of enforcement of credit contracts in the economy. Occupational choice and firm size are determined endogenously by an agent's type (ability and net wealth) and the credit market frictions. We then add a credit program that subsidizes the interest rate on loans. There is a fixed cost (which might be null) to apply for such loans in the form of bureaucracy and regulations. We show that for the United States, an interest rate credit subsidy does not have a significant effect on output per capita, but it can have important negative effects on wages and government finances. For Brazil, a developing country in which financial repression is high and the government subsidies heavily loans, our counter-factual exercises show that if all interest subsidies were cut, no significant quantitative effect would occur on output per capita, wages, inequality or government finances. However, when the interest rate subsidy is fixed at the level observed in Brazil, but access to the credit program is increased, then output and wages might both increase, as long as the interest rate subsidy does not not affect directly the spread on non-subsidized loans.

KEYWORDS: Financial frictions; Subsidized credit; Occupational choice; Development;

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1 Introduction

When markets function perfectly inequality reflects differences in effort, innate ability to acquire skills, to invest in capital, and/or to manage a labor force. In the credit market this would imply that more talented entrepreneurs will have more loans (if entrepreneurial talent is complementary to capital in production) independently of their initial net wealth and in the limit there will be equalization of the marginal productivity of capital among entrepreneurs. There will be no misallocation problem in this economy and the outcome will be efficient. However, when credit markets are imperfect due to screening costs, moral hazard problems or limited liability issues, then the marginal productivity of capital will not be equalized. In this case, in equilibrium, some entrepreneurs will have a higher marginal productivity of capital than others. There will be a misallocation problem and room to improve equilibrium outcomes.

The literature on quantitative macroeconomics has extensively studied the effects of financial (institutional) reforms that correct some of these credit market imperfections. Some of these reforms are: improvements in creditors' protection, changes in the bankruptcy law, or a decrease in implicit and explicit taxes on banks, among others. Some recent examples in this literature, which try to quantitatively evaluate the effects of such reforms in macroeconomic models, are: Amaral and Quintin (2010), Antunes, Cavalcanti, and Villamil (2008b), Buera and Shin (2008), Castro, Clementi, and MacDonald (2004), Erosa and Hidalgo-Cabrillana (2008), Greenwood, Sanchez, and Wang (2010), among others. The main finding of this literature is that financial reforms might have sizeable effects on efficiency, development and inequality and the effects are stronger when the economy is financially integrated in the international capital market.

This is a useful literature which shows the sizeable gains from financial reform. But some of these reforms might be costly to implement, mainly due to vested interest and political issues (e.g., Caselli and Gennaioli, 2008, Rajan and Zingales, 2003a,b). In this paper we study a related but different question to this literature on the quantitative effects of financial reform. Given the institutional level of a particular economy (strength of creditors' protection, efficiency of the judicial system, intermediation costs, etc.) and the potential problem of misallocation, is it optimal for the government to subsidize credit? In particular, what are the consequences of credit subsidies on development, inequality and on government finances?

In order to study such questions, we construct a general equilibrium model of economic development with heterogeneous agents and financial frictions *a la* Banerjee and Newman (1993) and Galor and Zeira (1993). Agents choose to be either workers or entrepreneurs, as in the Lucas (1978) "span of control" model. Each agent has an entrepreneurial ability and starts her life with an initial wealth. Agents live for J periods and in each period there is a measure one of cohort of agents leaving the economy and being replaced by an equal measure of agents. Agents value consumption in each period of their life and bequest for their offspring. There are two financial frictions: a cost to intermediate loans (e.g., collect information and organization costs) and a limited liability problem which maps into the degree of enforcement of credit contracts in the economy. Occupational choice and firm size are determined endogenously by an agent's type (ability and net wealth) and the credit market frictions. We then add a credit program in this economy which subsidized interest rate on loans. There is a fixed cost (which might be null) to apply for such loans in the form of bureaucracy and regulations. Income from this fixed cost and a payroll tax rate are the sources of revenue to finance this credit program.

Intuitively, when the government starts to subsidize interest rates entrepreneurs increase the demand for loans for a given interest rate. If the economy is small and financially integrated to the world market, then the interest rate will not change. This would increase capital accumulation and production. Note, however, that the tax rate has to increase to balance the government budget constraint, which decreases labor demand and production. In addition, if there are restrictions to capital flow, this demand effect will push interest rates up. This general equilibrium supply effect would decrease the profitability of entrepreneurial activity. Therefore, it is not clear what would be the aggregate impact of credit subsidies on development and we need to rely on numerical methods to solve out the model and implement counter-factual experiments.

Credit allocation and preferential interest rates have been a major policy by many governments, including, for instance, the United States with the Small Business Administration (SBA) loans and also in developing countries, such as South Korea, as reported by Lee (1996) and Brazil (e.g., Ribeiro and DeNegri, 2010, Souza-Sobrinho, 2010). For instance, in Brazil the National Development Bank (BNDES) provides subsidized credit and the size is not negligible: it accounts for about 27 percent of all productive credit in the country (see the details of this on subsection 3.2). The interest rate on such loans are much lower than the "market" interest rate on credit loans to firms. The interest rate on such loans might be as low as the basic Central Bank interest rate in Brazil, as we report in subsection 3.2. BNDES has no branches, and it provides credit mostly through commercial and regional development banks. Its resources come mainly from workers compulsory contributions and loans from the Brazilian Treasury at a rate lower than the Central Bank interest rate. In 2008-2010, for instance, the yearly nominal interest paid by government bonds (Selic) was about 12 percent, while the government was lending to BNDES at rate of roughly 6 percent. The final interest rate on BNDES loans contains also a spread charged by BNDES and some financial intermediary spread. See more on this in subsection 3.2. See also Ribeiro and DeNegri (2010) and Ottaviano and de Sousa (2008), among others, for more details about how BNDES operates and its credit lines.

Although this policy has been widely implemented by many countries, there is not much written on the aggregate effects of such policy on allocation and development in a quantitative macro model with entrepreneurs and financial frictions. There are few exceptions in which we build our paper on. Firstly, there is an older literature which built the foundations of the effects of credit subsidies in economies with financial frictions and credit rationing. See, for instance, de Meza and Webb (1988) and Smith and Stutze (1989).[1] In a more related work to ours, Gale (1991) uses a modified version of Stiglitz and Weiss (1981) model to study quantitatively the effects of credit programs on the economy. He provides important results on how credit subsidies affect quantitatively the economy. The difference between our model and his are as following: His model is static and is a partial equilibrium analysis, while ours is dynamic and all prices are endogenously determined. Another related and interesting article is Li (2002), who also investigates the effects of credit subsidies in a model with entrepreneurship and occupational choice. Although related, her policy is different from ours. In her model the government targets some entrepreneurs and pays a fraction of non-collateralized loans of such entrepreneurs. This is a type of loan guarantee program, which has been implemented in the United States. We evaluate a different policy. In our case, there are subsidized and non-subsidized interest rates and given a fixed cost to apply for subsidized loans, there is endogenous self-selection of entrepreneurs getting loans with government sponsored interest rates.[2] In addition, both articles mentioned above focus on the United States, while we also apply our model to Brazil a developing country in which fi-

[1]In a related article Armendariz de Aghion (1999) develops a model of a decentralized banking system in which banks are shown to both underinvest in, and undertransmit expertise in long-term industrial finance. Then, government support might reduce these problems, depending on the type of government interventions. Stiglitz (1994) discusses the foundation of different government interventions in financial markets including credit subsidies.

[2]Our model is also different from hers on how we model financial frictions. Besides the intermediation cost variable, in our model there is also an enforcement constraint and the subsidized loan program affects directly this enforcement restriction by decreasing interest rates on such loans. We also have a corporate sector, as in Quadrini (2000) and Wynne (2005), in which the credit market frictions are not necessarily binding. This is important since large corporations account for a significant fraction of output in the economy and do not face the same credit frictions as small entrepreneurs do.

nancial repression is known to be large and subsidized loans account for a sizeable fraction of total credit in the economy.

Our simulations for the United States suggest that quantitatively credit subsidies do not have a strong effect on output. For instance, when all credits are subsidize and the interest subsidy is such that there is no spread between the deposit and the borrowing rate (we also do experiments for lower levels of interest rate subsidies), then output per capita increases by less than 2 percent in the long run. However, the wage rate decreases by about 3 percent and wealth inequality increases. In order to balance the budget constraint, the payroll tax rate increases significantly. When there are entry costs to apply for these interest rate subsidies, then the effects on the economy are quantitatively smaller. Therefore, our results show that the effects of credit subsidies on the aggregate efficiency is small, but they have important impacts on government finances and distributional effects. Results are quantitatively similar when we consider an economy completely integrated to the international financial market and interest rates are exogenously given.

For the Brazilian case we found interesting results. In the counter-factual exercises in which we cut all interest subsidies in Brazil, then there is no significant effect on the economy in terms of output, wages, inequality and government finances. This implies that subsidized loans have not been effective to improve allocations in the economy. However, if we double the level of interest rate subsidies, then output per capita would increase, while wages would decrease by almost the same percentage change. There will be significant increases in the payroll tax rate and a distributional effect as in the United States. Interestingly, however, is that when we keep interest rate subsidies at the level currently observed in Brazil, but we increase access to such credit program (decrease the fixed cost), then output and wages might both increase as long as the effects on the payroll tax rate are not large enough. Therefore, given the interest credit subsidies attempt to expand access to its program and to reduce entry costs might lead to an increase in long run output, wages and welfare.

Observe that our model simulations are consistent to the empirical evidence on interest credit subsidies and development. Using manufacturing industries data, Lee (1996) shows that financial incentives in terms of cheap credit had no significant effect either on capital accumulation or Total Factor Productivity (TFP) in Korea. Using firm level data and an identification strategy based on some discontinuities on BNDES loans to control for selection bias, Ribeiro and DeNegri's (2009) estimates suggest that BNDES cheap credit had limited effects on TFP growth in Brazil. Using value added per worker, Ottaviano and de Sousa (2008) find similar results for Brazil. They show that BNDES loans increase productivity only for large projects but not for small loans and the aggregate effect is not statistically different from zero.[3]

Besides this introduction, this paper has three more sections. Section 2 describes the model economy, the credit policy and defines the equilibrium. Section 3 implements numerical experiments for Brazil and the United States. Section 4 contains the concluding remarks.

2 The Model

2.0.1 Environment

The economy is inhabited by overlapping generations of individuals who live for J periods. There is a mass one of each generation in each period. In the last period of life, each individual reproduces another such that population is constant. Time is discrete and infinite ($t = 0, 1, 2, ...$). There is one good that can be used for consumption or investment, or left to the next generation as a bequest. Agents can be workers or entrepreneurs. Entrepreneurs might need to borrow to operate their technology. There are two types of credit: subsidized and non-subsidized credit. We describe the details of the economy below. The model framework is similar to the one developed by Antunes, Cavalcanti, and Villamil (2008b). However, there are important differences. First of all, in Antunes, Cavalcanti, and Villamil (2008b), there is only one type of credit, while here there are two types of credit: subsidized and non-subsidized. In addition, in Antunes, Cavalcanti, and Villamil (2008b) agents live for only one period, while in the present model, agents live for J periods. This increases the possibility of internal financing, which might be important in evaluating the effects of credit policies on development. In the quantitative analysis, we do sensitiveness analysis with respect to J.

2.0.2 Endowments

In the beginning of their life, each agent is endowed with an initial wealth, b_t, inherited from the previous generation. In each period, an individual can be either a worker or an entrepreneur. Entrepreneurs create jobs and manage their labor force, n. As in Lucas (1978), each individual is endowed with a talent for managing, x, drawn from a continuous cumulative probability distribution function $\Gamma(x)$ where $x \in [0, 1]$. Agents accumulate assets, $\{a_t^j\}_{j=1}^J$ such that in each period agents are

[3]In a different avenue, Lazzarini and Musacchio (2011) find a significant effect of BNDES minority equity stakes on firm performance (return on assets). They attribute this result as a sign that having the development bank as a shareholder alleviates capital constraints faced by publicly traded companies.

distinguished by their age, assets and ability as entrepreneurs, (j, a_t^j, x_t). Notice that $a_t^1 = b_t$. Assume that an agent's talent for managing is not hereditary and (j, a_t^j, x_t) is public information.

2.0.3 Households

An agent born in period t has preferences over lifetime consumption profiles and bequest $(\{c_{t+j-1}^j\}_{j=1}^J; b_{t+J})$ and they are represented by the following utility function:

$$U_t = \sum_{j=1}^{J-1} \beta^{j-1} \frac{(c_{t+j-1}^j)^{1-\sigma} - 1}{1-\sigma} + \beta^{J-1} \frac{[(c_{t+J-1}^J)^{1-\gamma}(b_{t+J})^{\gamma}]^{1-\sigma} - 1}{1-\sigma}, \ \sigma > 0, \ \gamma > 0. \quad (1)$$

where $\beta \in (0, 1)$ corresponds to the subjective discount factor, $\sigma > 0$ denotes the inverse of the elasticity of intertemporal substitution and $\gamma > 0$ denotes the altruism factor. Notice that when $J = 1$ households are similar to those presented in Banerjee and Newman (1993), Galor and Zeira (1993), and Antunes, Cavalcanti, and Villamil (2008b). When $J \to \infty$, then households are infinite lived, as in the occupational model presented by Banerjee and Moll (2010). In this case, Banerjee and Moll (2010) show that financial frictions do not have any long run effect on output when the technology exhibits decreasing returns to scale in traded inputs (e.g., capital and labor). The intuition is that households in the long run can internally finance their capital and do not need to rely on borrowing to undertake their project. For financial frictions to have long run effect either the entrepreneurial ability x needs to change over time (as in Buera and Shin, 2008) or agents have to be finite lived (e.g., Antunes, Cavalcanti, and Villamil, 2008b).

In order to save notation we will drop the subscript t.

2.0.4 Production sectors

There are two production sectors in this economy. As in Quadrini (2000) and Wynne (2005), the first sector (*Corporate sector*) is dominated by large production units. The second sector (*Noncorporate sector*), is characterized by small production units where households engage in entrepreneurial activities.

Corporate sector

Firms in the corporate sector produce the consumption good through a standard constant returns to scale production function:

$$Y_t = B(K^c)^{\theta}(N^c)^{1-\theta}. \quad (2)$$

Firms in the corporate sector do not face financial restrictions similar to those found in the entrepreneurial sector. The corporate sector is characterized by large corporate organizations that do not face the enforcement and incentive restrictions faced by entrepreneurs. This implies that firms in this sector are able to borrow from banks at the equilibrium interest rate, r, or alternatively they can issue bonds at the equilibrium interest rate. They take prices as given and choose factors of production to maximize profits. Let w be the wage rate, δ be the rate of capital depreciation and τ^w be the payroll tax rate. The first order conditions of a representative corporate firm are

$$(1+\tau^w)w = (1-\theta)(K^c)^{\theta}(N^c)^{-\theta}, \tag{3}$$

$$r+\delta = \theta(K^c)^{\theta-1}(N^c)^{1-\theta}. \tag{4}$$

Noncorporate sector

Managers operate a technology that uses labor, n, and capital, k, to produce a single consumption good, y, that is represented by

$$y = f(x;k,n) = x^{\nu}(k^{\alpha}n^{1-\alpha})^{1-\nu} + (1-\delta)k, \quad \alpha,\ \nu,\delta \in (0,1). \tag{5}$$

Managers can operate only one project. Entrepreneurs finance part of their capital through their own savings, and part by borrowing from financial intermediaries. Entrepreneurs face financial restrictions, as we will describe below.

2.0.5 The capital market

Agents have two options in which to invest their assets:

- Financial Intermediaries: Agents can competitively rent capital to financial intermediaries (banks) and earn an endogenously determined interest rate, r.
- Private Equity: Agents can use their own capital as part of the amount required to operate a business. They might borrow the remaining capital they require from a bank at interest rate r_B.

2.0.6 Financial intermediaries

Financial intermediaries face a cost η for each unit of capital intermediated. Parameter η reflects transaction costs such as bank's operational costs to intermediate among agents or bank regulations (e.g., reserve and liquidity requirements). We do not model explicitly η and take this as given.[4] For expositional and computational purposes, we use the equivalent setting where all agents deposit their initial wealth in a bank and earn return r. The banks lend these resources to entrepreneurs, who use their initial wealth as collateral for the loan. The interest rate on the part of the loan that is fully collateralized is r, while the rate on the remainder is r_B. Competition among banks implies that the effective interest rate on borrowing is $r_B = r + \eta$.[5]

There is a limited liability problem in the credit market. Borrowers cannot commit *ex-ante* to repay. Those that default on their debt incur a cost equal to percentage ϕ of output net of wages. This penalty reflects the strength of contract enforcement in the economy. Financial intermediaries will offer a contract that is incentive compatible, such that it is the self-interest of borrowers to repay.

2.0.7 Government

There is a government in this economy, which raises revenues through a payroll labor tax, τ^w to finance a given government spending, g, and to subsidize credit, such that the borrowing rate of the subsidized credit is equal to $r_B - \tau^c$. We assume that g is exogenously given and does not change with changes in the credit policy. For entrepreneurs to raise subsidized capital, they have to pay a fixed cost ζ in terms of regulation and bureaucracy. We will also consider in the quantitative exercises the case in which ζ is zero and therefore all credits receive government subsidies.

2.0.8 Households' Problem

Let $V^{ns}(x, a^j; w, r)$ and $V^s(x, a^j; w, r)$ be the indirect profit function of an entrepreneur with managerial ability x and asset value a^j when the project is financed by a non-subsidized and subsidized credit, respectively. w corresponds to the wage rate. The problem of a household can be written as:

$$\max_{a^{j\prime}, c^j, b_{J+1}} \sum_{j=1}^{J-1} \beta^{j-1} \frac{(c^j)^{1-\sigma} - 1}{1-\sigma} + \beta^{J-1} \frac{[(c^J)^{1-\gamma}(b_{J+1})^{\gamma}]^{1-\sigma} - 1}{1-\sigma}, \tag{6}$$

[4] See Antunes, Cavalcanti, and Villamil (2010) for a model in which η arises endogenously due to an explicit financial intermediation technology which depends on capital and labor.

[5] In an equivalent environment, we could also assume an oligopolistic banking sector in which banks compete *à la* Bertrand, where η is the marginal cost in financial intermediation.

subject to

$$\begin{aligned}
c^j + a^{j'} &\leq W(x, a^j; w, r) + (1+r)a^j + tr, && (7)\\
W(x, a^j; w, r) &= \max\{w, \max\{V^{ns}(x, a^j; w, r), V^s(x, a^j; w, r)\}\}, && (8)\\
c^j, a^{j'}, b^{J+1} &\geq 0,\ j = 1, ...J,\ \text{and}\ a^{J'} = b^{J+1},\ a^1 = b. && (9)
\end{aligned}$$

Equation (7) corresponds to the budget constraint of the household where $W(x, a^j; w, r)$ corresponds to the income of the household and tr are transfers; Equation (8) implies that households will choose the occupational choice which maximizes income; and condition (9) states the constraints on the choice variables and initial conditions.

2.0.9 Entrepreneurs

Households who have sufficient resources and managerial ability to become entrepreneurs choose the level of capital and the number of employees to maximize profit subject to a technological constraint and (possibly) a credit market incentive constraint. Let us first consider the problem of an entrepreneur for a given level of capital k and wages w:

$$\pi(k, x; w) = \max_n f(x; k, n) - (1+\tau^w)wn. \tag{10}$$

Equation (10) yields the labor demand of each entrepreneur, $n(k, x; w)$. Substituting $n(k, x; w)$ into (10) yields the entrepreneur's profit function for a given level of capital, $\pi(k, x; w)$. Let d be the amount of self-financed capital (or, equivalently, the part of the loan that is fully collateralized by the agent's personal assets), and l be the amount of funds borrowed from a bank (or, equivalently, the amount of the loan that is not collateralized).

Each entrepreneur maximizes the net income from running the project

$$V^h(a^j, x; w, r) = \max_{d\geq 0,\ l\geq 0} \pi(d+l, x; w) - (1+r)d - (1+r+\eta-\tau^c \mathbf{1}_s)l - \mathbf{1}_s\zeta,\ h = ns, s, \tag{11}$$

subject to the credit market incentive constraint and feasibility

$$\phi\pi(d+l, x; w) \geq (1+r+\eta-\tau^c\mathbf{1}_s)l, \tag{12}$$

$$a^j \geq d. \tag{13}$$

Indicator function $\mathbf{1}_s$ takes value 1 if the loan is subsidized and zero otherwise. Notice that it is profitable to take a subsidized loan when $l \geq \frac{\zeta}{\tau^c}$. Incentive compatibility constraint (12) guarantees that *ex-ante* repayment promises are honored (the percentage of profits the financial intermediary seizes in default is at least as high as the repayment obligation). We can rewrite this constraint as

$$l^h(a^j, x; w, r) \leq \frac{\phi}{1 + r + \eta - \tau^c \mathbf{1}_s} \pi(k^h(a^j, x; w, r), x; w), h = ns, s.$$

Feasibility constraint (13) states that the amount of self finance, d, cannot exceed the value of assets, a^j. Notice that the loan size depends whether the credit is subsidized or not. The constrained problem yields optimal policy functions $d(a^j, x; w, r)$ and $l^h(a^j, x; w, r)$ that define the size of each firm,

$$k^h(a^j, x; w, r) = d(a^j, x; w, r) + l^h(a^j, x; w, r), \;\; h = ns, s.$$

It is straightforward to show that when $\eta - \tau^c > 0$ entrepreneurs invest their entire value of assets in their firm as long as $d \leq k^*(x; w, r)$, where $k^*(x; w, r)$ corresponds to the problem of a unconstrained firm. Therefore, $l^h(a^j, x; w, r) = 0$ for $a^j \geq k^*(x; w, r)$. This follows immediately from the fact that the cost of self-financing is lower than using a financial intermediary. Moreover, for credit constrained entrepreneurs, we have that $l^h(a^j, x; w, r)$ is increasing with both x and b.

2.0.10 Occupational choice

The occupational choice of each agent defines his income. Define $\Omega = [0, \infty) \times [0, 1]$. For any $w, r > 0$, an agent (a^j, x) will become an entrepreneur if $(a^j, x) \in E(w, r)$, where

$$E(w, r) = \{(a^j, x) \in \Omega : \max\{V^{ns}(x, a^j; w, r), V^s(x, a^j; w, r)\} \geq w\}. \tag{14}$$

The complement of $E(w, r)$ in Ω is $E^c(w, r)$. If $(a^j, x) \in E^c(w, r)$, then agents are workers. In addition, an agent (a^j, x) will get a subsidized loan if $(a^j, x) \in E^s(w, r) \subseteq E(w, r)$, where

$$E^s(w, r) = \{(a^j, x) \in E(w, r) : V^s(x, a^j; w, r) \geq V^{ns}(x, a^j; w, r)\}. \tag{15}$$

The following Lemma applies:

Lemma 1 *Define* $a_e^j(x; w, r)$ *as the curve in set* Ω *such that* $\max\{V^{ns}(a^j, x; w, r), V^s(a^j, x; w, r)\} = w$. *Then there exists an* $x^*(w, r)$ *such that* $\frac{\partial a_e^j(x;w,r)}{\partial x} < 0$ *for* $x > x^*(w, r)$ *and* $\frac{\partial a_e^j(x;w,r)}{\partial x} = -\infty$ *for* $x = x^*(w, r)$. *In addition:*

1. *For all* $x > x^*$, *if* $a^j < a_e^j(x; w, r)$, *then* $(a^j, x) \in E^c(w, r)$.

2. *For all* $x > x^*$, *if* $a^j \geq a_e^j(x; w, r)$, *then* $(a^j, x) \in E(w, r)$.

Proof. See Antunes, Cavalcanti, and Villamil (2008a). ■

Moreover, entrepreneurs use subsidized credit if and only if $(a^j, x) \in E^s(w, r)$, where

$$E^s(w, r) = \{(a^j, x) \in E(w, r) : V^s(x, a^j; w, r) \geq V^{ns}(x, a^j; w, r)\}. \qquad (16)$$

Entrepreneurs apply for subsidized loans when $l^{ns}(a^j, x; w, r) \geq \frac{\zeta}{\tau^c}$. There are two cases to investigate whether entrepreneurs use subsidized credit or not. Firstly, when condition (12) does not bind, then $l^{ns}(a^j, x; w, r)$ is decreasing in a^j as long as $a^j < k^*(x; w, r)$, and increasing in x. In this case, condition $l^{ns}(a^j, x; w, r) = \frac{\zeta}{\tau^c}$ defines $\bar{a}_s^j(x; w, r)$ with $\frac{\partial \bar{a}_s^j(x;w,r)}{\partial x} > 0$. Moreover, for each $(x, a^j) \in E(w, r)$, if a^j is in the neighborhood of $\bar{a}_s^j(x; w, r)$ and $a^j < \bar{a}_s^j(x; w, r)$, then $l^{ns}(a^j, x; w, r) > \frac{\zeta}{\tau^c}$ and $(a^j, x) \in E^s(w, r)$. On the other hand, if equation (12) binds with equality, then $l^{ns}(a^j, x; w, r)$ is increasing in both a^j and x and condition $l^{ns}(a^j, x; w, r) = \frac{\zeta}{\tau^c}$ defines $\bar{a}_s^j(x; w, r)$ with $\frac{\partial \bar{a}_s^j(x;w,r)}{\partial x} < 0$. Then, for each $(x, a^j) \in E(w, r)$, if a^j is in the neighborhood of $\bar{a}_s^j(x; w, r)$ and $a^j > \bar{a}_s^j(x; w, r)$, then $l^{ns}(a^j, x; w, r) > \frac{\zeta}{\tau^c}$ and $(a^j, x) \in E^s(w, r)$.

Figure 1 shows occupational choice in (a^j, x) space for the economy in subsection 3.1 in which $\zeta = 0.2w$ and $\tau^c = 1\%$ per year. Lemma 1 and figure 1 indicate that agents are workers when the quality of their project is low, i.e., $x < x^*(w, r)$. For $x \geq x^*(w, r)$ agents may become entrepreneurs, depending on whether or not they are credit constrained. If initial wealth is very low, agents are workers even though their entrepreneurial ability is higher than $x^*(w, r)$. The negative association between $a_e^j(x; w, r)$ and x suggests that managers with better managerial ability need a lower level of initial wealth to run a firm. The lightest shaded area is the region in which agents apply for subsidized loans.

The point is that controlling for the agent's net worth, a^j, loan size varies positively with x and we should expect a positive relationship between entrepreneurial quality and the use of subsidized credit. The relationship between the use of subsidized credit and asset value is ambiguous. The reason is that, in one hand, a large value of assets implies that the restriction (12) does not bind and we should expect rich entrepreneurs to rely less on outside finance and therefore on subsidized credit, since it is profitable to apply for such loan if and only if $l^{ns}(a^j, x; w, r) > \frac{\zeta}{\tau^c}$. However, for high ability entrepreneurs, the incentive compatible constraint might bind

Figure 1: Occupational choice.

and therefore a higher level of assets loosens borrowing constraint and increase the option to use subsidized credit. In order to investigate the effects of credit subsides on occupational choice, firm size, borrowing, output and prices we need to solve this general equilibrium model numerically. The definition of the equilibrium is given below.

2.0.11 Competitive equilibrium

Let Υ_0 be the initial asset distribution which is exogenously given and let Υ be the wealth (asset) distribution at some period t, which evolves endogenously across periods. Define $P(a^j, A) = Pr\{a^{j'} \in A | a^j\}$ as a non-stationary transition probability function, which assigns a probability for an asset in $t+1$ to be at A for an agent that has asset a^j. The law of motion of the Asset distribution is

$$\Upsilon' = \sum_{j=1}^{J} \int P(a^j, A) \Upsilon(da^j). \tag{17}$$

In a competitive equilibrium, agents optimally solve their problems and all markets clear. The agents' optimal behavior was previously described in detail. It remains, therefore, to characterize the market equilibrium conditions. Since the consumption good is the numeraire, two market clearing conditions are required to determine the wage and interest rate in each period. The labor and capital market equilibrium equations are:

$$\sum_{j=1}^{J} \iint_{z\in E(w,r)} n(x,a^j;w,r)\Upsilon(da^j)\Gamma(dx) + N^c = \sum_{j=1}^{J} \iint_{z\in E^c(w,r)} \Upsilon(da^j)\Gamma(dx), \qquad (18)$$

$$\sum_{j=1}^{J} \iint_{z\in E(w,r)} k(a^j,x;w,r)\Upsilon(da^j)\Gamma(dx) + K^c = \sum_{j=1}^{J} \iint a^j \Upsilon(da^j)\Gamma(dx). \qquad (19)$$

In addition, the government budget constraint is satisfied with equality, such that:

$$\sum_{j=1}^{J} \iint_{z\in E^s(w,r)} \tau^c l(x,a^j;w,r)\Upsilon(da^j)\Gamma(dx) + g = \sum_{j=1}^{J} [\iint_{z\in E(w,r)} \tau w n(x,a^j;w,r)\Upsilon(da^j)\Gamma(dx) \qquad (20)$$
$$+ \iint_{z\in E^s(w,r)} \zeta \Upsilon(da^j)\Gamma(dx)].$$

Observe that we are implicitly assuming that the bureaucracy cost ζ is used to finance the organizational structure and procedures to manage these subsidized loans. Alternatively, we could have assumed that this fixed cost is redistributed back to all households. In this case, the increase in the payroll tax rate, τ^w, to finance credit subsidies will be, in general, larger than in the case in which the fixed cost is assumed to be part of the government revenue. Quantitatively results are roughly the same using the two approaches and for the sake of space we only report the simulations in which equation (20) is satisfied.

Finally, we assume that intermediation costs, η, are redistributed back to households:

$$\sum_{j=1}^{J} \iint tr\Upsilon(da^j)\Gamma(dx) = \sum_{j=1}^{J} \iint_{z\in E(w,r)} \eta l(a^j,x;w,r)\Upsilon(da^j)\Gamma(dx). \qquad (21)$$

Antunes, Cavalcanti, and Villamil (2008a) prove the existence of a unique stationary equilibrium that is fully characterized by a time invariant asset distribution and associated equilibrium factor prices. From any initial asset distribution and any interest rate, convergence to this unique invariant asset distribution occurs. They also describe a direct, non-parametric approach to compute the stationary solution.

3 Measurement

In order to study the quantitative effect of credit subsidies on entrepreneurship, economic development, inequality, among other variables, we most assign value for the model parameters. We do this for both the United States and the Brazilian economies. The United States example corresponds to the case of a well developed financial market with relatively small intermediation costs. The Brazilian case corresponds to a repressed financial market with large intermediation costs. In addition, Brazil's main development bank (BNDES) subsidizes heavily interest rates.

3.1 United States

3.1.1 Calibration

Firstly, the model economy is calibrated such that the long run equilibrium matches some key statistics of the U.S. economy. We assume that $J = 9$ and that each model period is 5 years.[6] As a result, each agent has a productive lifetime of 45 years. Assume that the cumulative distribution of managerial ability is given by $\Gamma(x) = x^{\frac{1}{\epsilon}}$. When ϵ is equal to one, entrepreneurial talent is uniformly distributed in the population. When ϵ is greater than one the talent distribution is concentrated among low talent agents.

There are fourteen parameters to be determined: six technology parameters $(\theta, B, \nu, \alpha, \delta, \epsilon)$, three utility parameters (σ, β, γ), and five institutional and policy parameters $(\phi, \eta, \zeta, \tau^w, \tau^c)$. Table 1 lists the value of each parameter in the baseline economy and includes a comment on how each was selected. Below we describe in the detail how we set their value.

We set ν and α such that in the entrepreneurial sector 55% of income is paid to labor, 35% is paid to the remuneration of capital, and 10% are profits.[7] Therefore, $\nu = 0.1$ and $\alpha = 0.39$. In the corporate sector, we set $\theta = 0.40$, which implies a capital income share of 40%, which is also consistent to Gollin (2002). We assume that the capital stock depreciates at a rate of 6% per year, which is a number used in the growth literature (e.g., Gourinchas and Jeanne, 2006). The coefficient of relative risk aversion σ is set at 2.0, which is consistent with micro evidence in Mehra and Prescott (1985). We estimate η directly. Bech and Rice (2009, page A88, table A.1) show that in the United States the average from 1999 to 2008 of banks' non-interest

[6] Results are very similar when we consider the model when $J = 1$ as in Galor and Zeira (1993) and when parameters are calibrated to match the same statistics considered in the parameterization.

[7] This is consistent to Gollin (2002).

Table 1: Parameter values, baseline economy. A time period is 5 years and $J = 9$

A. Fixed parameters and their sources		
Parameters	**Values**	**Comment/Observations**
ν	0.10	Share of profits in entrepreneurial activities, based on Gollin (2002)
α	0.39	Capital share in entrepreneurial activities, based on Gollin (2002)
θ	0.40	Capital share in the corporate sector, based on Gollin (2002)
δ	0.2661	Yearly depreciation rate of 6%
η	0.2126	Banks' overhead costs and taxes divided by total assets, based on Bech and Rice (2009). Yearly rate of 3.927%.
τ^w	0.33	Payroll tax rate, based on Jones, Manuelli, and Rossi (1993)
τ^c	0	No credit subsidy policy
ζ	0	No credit subsidy policy
B. Jointly calibrated parameters and statistics matched		
ϵ	4.47	Entrepreneurial Gini index of 0.45 (see Quadrini, 1999);
ϕ	0.225	7.5% of entrepreneurs in the population (see Cagetti and De Nardi, 2009);
γ	0.8355	Ratio of bequests to labor earnings is 4.5% (see Gokhale and Kotlikoff, 2000)
β	0.9039	Capital to output ratio equal to 2.55, Penn World Tables 6.2
B	0.5246	60% of aggregate capital is employed in the corporate sector (see Quadrini, 2000)

expenses (overhead costs) over assets is about 3.365 percent. Bech and Rice (2009) also report that the average value for taxes over total assets paid by banks during the same period was 0.562 percent, which implies that the total level of intermediation costs in equilibrium is equal to $\eta = 0.03927$. We set $\tau^w = 0.33$ such that we match the average tax rate on labor income in the United States (c.f. Jones, Manuelli, and Rossi, 1993). We first consider an economy without credit subsides, such that $\tau^c = 0$ and $\zeta = 0$.

The values of five remaining parameters must be determined. They are: the productivity parameter of the corporate sector, B; the curvature of the entrepreneurial ability distribution, ϵ; the subjective discount factor, β; the altruism utility factor, γ; and the strength of financial contract enforcement, ϕ. These five parameters are chosen such that in the stationary equilibrium we match five key statistics of the United Sates economy: the capital to output ratio, which is equal to 2.55;[8] the percent of entrepreneurs over the total population, which is about 7.5% (see Cagetti and De Nardi, 2009); the Gini index of entrepreneurial earnings, which corresponds to roughly 45% (see Quadrini, 1999); 60 percent of aggregate capital is employed in the corporate sector (see Quadrini, 2000); and the ratio of bequests to labor earnings is roughly 4.5%, which is the number estimated by Gokhale and Kotlikoff (2000).

[8]The estimated value of the capital to output ratio ranges from 2.5 (see Maddison, 1995) to 3 (see Cagetti and De Nardi, 2009). Using the Heston, Summers, and Aten (2006) Penn World Tables 6.2 and the inventory method, we construct the capital to output ratio for the United States. The estimated value for the United States is 2.55. The value for β is equal to 0.9039. Since the model period is 5 years, this implies that agents discount the future at a rate of about 2% per year.

Table 2: Basic statistics, U.S. and baseline economy. Sources: International Financial Statistics database, Bech and Rice (2009), Cagetti and De Nardi (2009), Castañeda, Díaz-Giménez, and Ríos-Rull (2003), Gokhale and Kotlikoff (2000), Heston, Summers, and Aten (2006), McGrattan and Prescott (2000), Quadrini (1999), Quadrini (2000).

	U.S. economy	Baseline economy
Overhead and tax as perc. of total bank assets (%)	3.927	3.927
% of entrepreneurs (%)	7.50	7.49
Entrepreneurs' income Gini (%)	45	45.02
Share of capital in the corporate sector (%)	60	60
Capital to output ratio	2.55	2.52
ratio of bequests to labor earnings (%)	4.5	4.54
Intermediated capital to output ratio	1.8	1.83
Wealth Gini (%)	78	39.27

The model matches the U.S. economy fairly well along a number of dimensions that were calibrated (the first six statistics in table 2), as well as some statistics that were not calibrated, such as the level of intermediated capital to output ratio. McGrattan and Prescott (2000) report that the intermediated capital to output ratio in the United States is equal to 1.8 and that the corporations are the leading institutions of capital ownership in the United States. If we assume that most of the capital in the corporate sector is intermediated by either financial institutions, or by issuing bonds and stocks, we have that our measure of intermediate capital is equal to 1.83. The measure of intermediated capital in the entrepreneurial sector is about 34.1% of output. Finally, the model does not match well the wealth Gini: the model prediction is roughly 39%, while in the data it is 78% (see Castañeda, Díaz-Giménez, and Ríos-Rull, 2003). But recall that every worker receives the same equilibrium wage rate in the model economy, while in the data there is much more labor heterogeneity.[9]

Finally, figure 2 shows the amount of wealth over national income held by each generation. Notice that it has an inverted-U shape. The amount of wealth held by the first generation is about 1.52 percent of the national income. It increases monotonically until it reaches about 3.5 percent of the national income in generation 7 and it decreases to 2.9 percent of the national income in the last generation. Agents accumulate assets to finance their business, to smooth consumption over time, and to leave bequests to their offspring.

[9]Labor income shocks can be added to increase the income and wealth Gini indexes, but they increase the complexity of the model without adding any new insights.

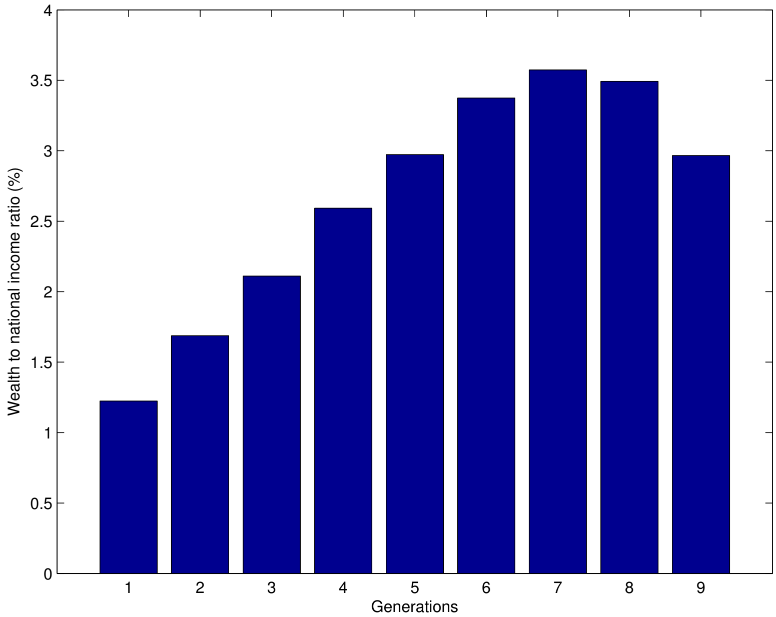

Figure 2: Life-cycle wealth: Wealth to national income ratio for different generations.

3.1.2 Quantitative Experiments

We then numerically explore how the equilibrium properties of the model change with benchmark variations in the credit subsidy policy. We examine the model's predictions along six dimensions: output per capita as a fraction of the baseline value, the wage rate as a fraction of the baseline value, the wealth Gini coefficient, the fraction of subsidized loans, the payroll tax rate and the cost of the program as a share of income. In appendix A, we also provide a detailed table and explore the effects of credit subsidies on the following additional variables: capital to output ratio, fraction of entrepreneurs in the economy, interest rate and entrepreneurs' income Gini. All statistics correspond to the stationary equilibrium of the model.

Figure 3 describes the model's predictions as the value of the credit subsidy changes from 0 to a value such that the borrowing and the deposit rates are the same. We evaluate the effects for different values of the fixed cost ζ. The value of ζ varies from 0 (black solid line with a diamond marker) - case in which all loans receive subsidies - to 60% of the baseline wage (blue solid line with a triangle marker) - case in which there is endogenous selection for subsidized loans. We also consider values for ζ in between these two values. Results for intermediate values of ζ are displayed in the grey dotted lines. When τ^c raises entrepreneurs increase the demand for loans for a given interest rate. This is a demand effect. If the economy is small and financially integrated to the world market, then the interest rate will not change. But if there are restrictions to capital flow, this demand effect will push interest rates up. This in turn would decrease the profitability of entrepreneurial activity. This is a general equilibrium supply effect. In addition, larger loans increase entrepreneurial production, and the accumulation of capital, which decreases the interest rate in the long run. Therefore, it is not clear what would be the impact of credit subsidies on development. Notice also that the payroll tax rate has to increase to balance the government budget constraint, which decreases labor demand and production.

What we can observe directly from figure 3(a) is that quantitatively credit subsidies do not have a strong effect on output. When there is no fixed cost and credit subsidies increase from $\tau^c = 0$ to $\tau^c = 3.927\%$ per year, we observe the following: Output per capita increases by less than 2% in the long run;[10] the wage rate decreases by about 3%; wealth inequality increases. The Gini coefficient for households' wealth increases by more than 10%; the payroll tax rate increases sharply from 0.33 to 0.4 to balance the government budget constraint, since government spending increases by 10 percentage points. When the fixed cost is positive, then the effects of credit subsidies on all variables go in the same direction as when there is no fixed cost and are, in general, quantitatively smaller; including the positive effects on output and the negative effects on the wage rate and government finances. When fixed costs are positive, there is endogenous selection to subsidized loans and not all entrepreneurs benefit from this program. Therefore, our results show that the effects of credit subsidies on aggregate economic efficiency are small, but they have not negligible impacts on government finances and important distributional effects. There is a transfer of income from workers to entrepreneurs who are a small measure of the total labor force.[11]

In order to investigate whether or not the general equilibrium effect offset the demand effect of credit subsidies on economic efficiency, we also consider an economy financially integrated to the international capital markets. In this case, financial intermediaries have access to an elastic supply of funds and the interest rate is exogenously given and it is equivalent to the interest rate in the baseline economy, which is roughly 4.47% per year. The difference of the effects of credit subsidies on the economy for the cases in which the interest rate is exogenous or endogenous might be large, as Castro, Clementi, and MacDonald (2004) and Antunes, Cavalcanti, and Villamil (2008b) show that this general equilibrium effect is quantitatively important in the analysis of financial reforms that improve creditors' right.

[10] When $\zeta = 0$, the larger effect is when $\tau^c = 2.5\%$ per year. In this case, output per capita increases by 1.81%.

[11] In the baseline economy, the measure of entrepreneurs is 7.5% of the labor force. The share of entrepreneurs increase slightly with credit subsidies. In the economy without fixed costs, it goes from the baseline value of 7.49% to 7.93% when the credit subsidy rate is 3.927% per year. See table 6 in appendix A.

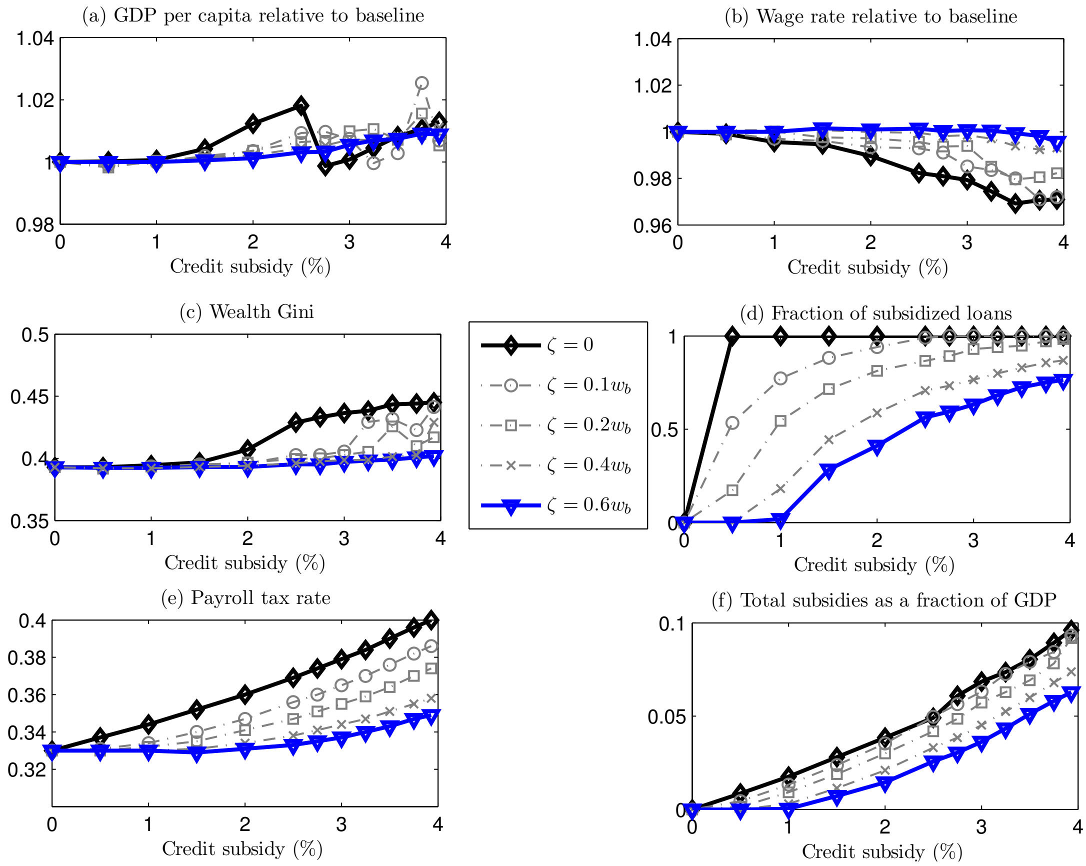

Figure 3: Economy with endogenous interest rate. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) Fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP. Different lines correspond to economies with different levels of the fixed cost, ζ.

Figure 4 shows the model's predictions in an economy completely open to capital flows as the value of the credit subsidy rises from 0 to a value such that the borrowing and the deposit rates are the same for different levels of the fixed cost (see also table 7 in appendix A). The figure shows that the relationship between the selected variables and credit subsidies present the same pattern of the case in which the interest rate is endogenous. It shows that the effects on output are slightly stronger than in the case with an endogenous interest rate, but the quantitative difference is small. The maximum effect in output occurs when $\tau^c = 3.927\%$ per year and the fixed cost, ζ is equal to 10% of the baseline wage. In this case, output increases by 2.26% relative to the baseline. Notice, however, that the negative effects on the wage rate and government finances are also stronger. The wage rate decreases by more than 5% when fixed costs are zero and the subsidy rate goes from 0 to $\tau^c = 3.927\%$

per year.[12] But overall there not major quantitative differences. In fact, the interest rate does not change much with credit subsidies, as we can observe in table 6 in appendix A.[13]

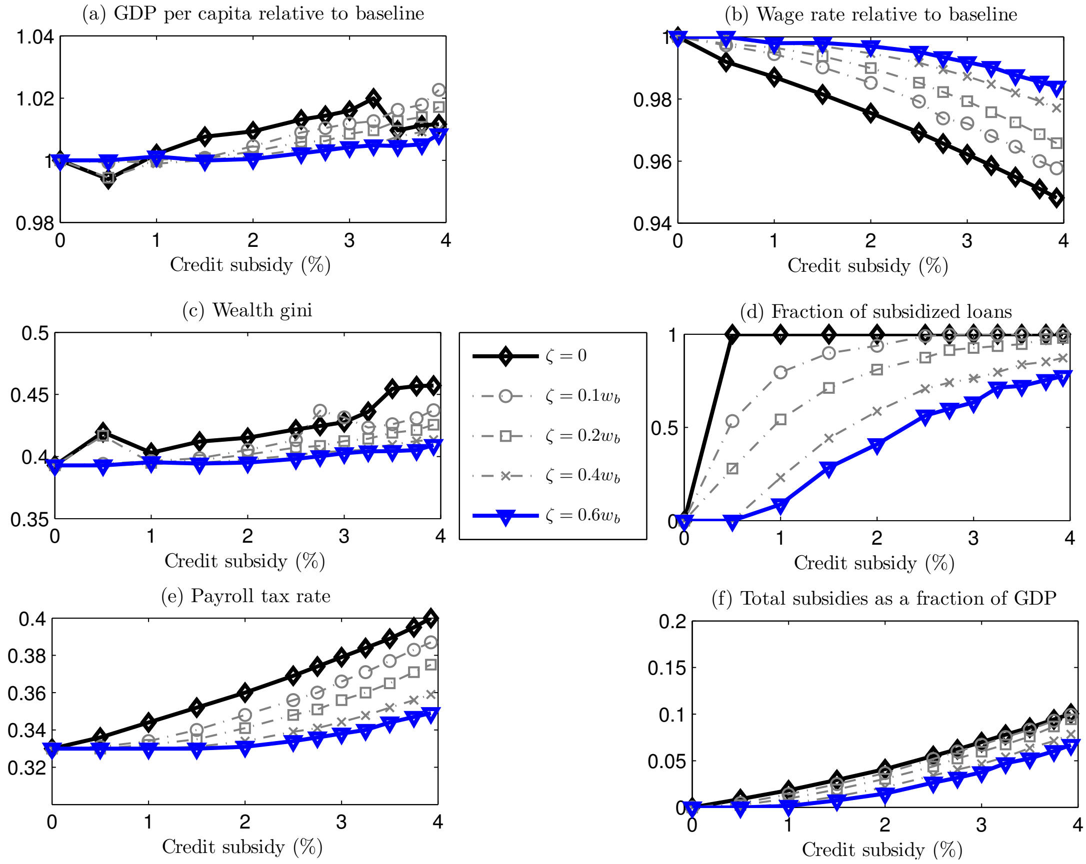

Figure 4: Economy with exogenous interest rate. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) Fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP. Different lines correspond to economies with different levels of the fixed cost, ζ.

[12] In the endogenous interest rate case, the wage rate decreased by about 3% when $\zeta = 0$ and τ^c goes from zero to 3.927% per year.

[13] Observe that the long run interest rate decreases with credit subsidies. Although the demand effect pushes interest rates up, more production and capital accumulation decreases the marginal productivity of capital and therefore decreases the interest rate. In addition, the payroll tax rate increases significantly and this decreases the demand for capital and production. The quantitative exercises show that this last effect is stronger than the direct demand effect.

3.2 Brazil

3.2.1 Calibration

Now we calibrate the model economy such that the long run equilibrium matches some key statistics of the Brazilian economy. It is important to emphasize that we are not comparing the Brazilian and the United States economies. Our exercises are purely counterfactuals within the same economy. Our objective here is to provide quantitative analysis on the effects of changing the credit subsidy policies in Brazil and it is not our goal to account for any difference in outcomes and policies between the two economies.

We keep $J = 9$ and also assume that the model period is 5 years. As before, we have to estimate fourteen parameters. Table 3 lists the value of each parameter for the Brazilian economy and includes a comment on how each was selected.

Firstly, Gollin (2002) shows that capital and labor shares in income are roughly constant across countries. So we use the same values in 1 for the technology parameters ν, α and θ, as well as for the depreciation rate of the capital stock, δ. We also assume that the coefficient of relative risk aversion σ in Brazil is similar to the United States level.[14] Beck, Demirgüç-Kunt, and Levine (2009) report that the ratio of banks' overhead costs to total assets is about 11 percent in Brazil. In addition, Demirgüç-Kunt and Huizinga (1999) show that the value for taxes over total assets paid by banks is roughly 1 percent. Therefore, we set η such that the annual value of intermediation costs is 12 percent.[15] We set the payroll effective tax rate to be $\tau^w = 0.18$, which is a value reported by Paes and Bugarin (2006) for the Brazilian economy.

We now set the value for the policy parameter τ^c and institutional parameter ζ. Brazilian public banks are responsible for about 30 percent of all credits in the country. However, not all credit provided by public banks are subsidized. The Brazilian National Development Bank (BNDES) is the main institution to provide subsidized credit in the country and it also provides funding for other regional development banks in Brazil. According to Sant'Anna, Borça-Junior, and de Araujo (2009), BNDES is responsible for about 18 percent of all credit. According to the World Development Indicators, private credit over output in Brazil has been growing recently and in 2008 it reached about 50 percent of GDP. However, notice that not

[14] Issler and Piqueira (2000), using the Euler equation and consumption and interest rate data, estimate the coefficient of relative risk aversion for Brazil and find a number in the interval from 1.10 to 4.89 with annual data.

[15] Notice that the interest margin in Brazil reported by Beck, Demirgüç-Kunt, and Levine (2009) is about 14 percent. However, the net interest margin contains also loan loss provision and after tax bank profits, which are not explicitly modeled here.

all loans go to firms. Sant'Anna, Borça-Junior, and de Araujo (2009) report that about 35 percent of the total credit in Brazil are either to finance family consumption or housing. Therefore, credit to production corresponds to about 30 percent of income and BNDES loans account for about 27 percent of all productive credit. Therefore, we will calibrate ζ such that the share of subsidized credit is about 27 percent of all credit in our model economy.

BNDES resources come mainly from workers contributions and loans from the Brazilian Treasury at a rate lower than the Central Bank interest rate. In 2008-2010, for instance, the yearly nominal interest paid by government bonds (Selic) was about 12 percent, while the government was lending to BNDES at about 6 percent. It is important to notice that BNDES has no branches, and it provides credit mostly through commercial and regional development banks,[16] which can access BNDES resources under lower rates and offer credit to firms. The final interest rate in BNDES credit lines contains also an interest rate spread charged by BNDES of about 1.73 percentage points in 2009-2010 (Average value. See BNDES, 2010) and the financial intermediaries spread[17] Therefore, we assume that BNDES provide at an annualized rate a 4.3 percentage points subsidy on loan interest rates, such that $\tau^c = 0.2343$. We then calibrate ζ such total subsidized credit accounts for about 27 of all productive credit in the economy.

As before, it remains to determine the value of the following five parameters: the productivity parameter of the corporate sector, B; the curvature of the entrepreneurial ability distribution, ϵ; the subjective discount factor, β; the altruism utility factor, γ; and the strength of financial contract enforcement, ϕ. These five parameters are chosen such that in the stationary equilibrium we match the following statistics of the Brazilian economy: the capital to output ratio, which is equal to 2.2;[18] the percent of entrepreneurs over the total labor force;[19] the Gini index

[16]In some credit lines borrowers can apply directly to BNDES, but the majority of loans are through commercial and regional development banks.

[17]BNDES loans have a longer term than other types of credit, but it is also requires a large collateral. The maturity of the loan for firms are in general, however, within 60 months, the time period of our model economy.

[18]Using the Heston, Summers, and Aten (2006) Penn World Tables 6.2 and the inventory method, we find a value of 2.2 for the Brazilian economy. The value for β is equal to 0.9039. Since the model period is 5 years, this implies that agents discount the future at a rate of about 2% per year.

[19]Using the microdata of the 2008 Brazilian households survey (PNAD), we find that the percent of the people in the labor force who employ at least one worker is about 2%. Self-employed accounts for 10% of the labor force. However, it is hard to distinguish those self-employed who are managing a business or who are employed as a worker to avoid Brazilian strict labor laws and regulations. If we make a filter, such that we consider entrepreneurs those who manage a labor force and whose income as an entrepreneur is higher than the minimum wage (in 2008 it was R$415), then the percent of entrepreneurs in the labor force is about 7.6%.

Table 3: Parameter values, baseline economy. A time period is 5 years and $J = 9$

A. Fixed parameters and their sources		
Parameters	**Values**	**Comment/Observations**
ν	0.10	Share of profits in entrepreneurial activities, based on Gollin (2002)
α	0.39	Capital share in entrepreneurial activities, based on Gollin (2002)
θ	0.40	Capital share in the corporate sector, based on Gollin (2002)
δ	0.2661	Yearly depreciation rate of 6%
η	0.7623	Banks' overhead costs and taxes divided by total assets, based on Beck, Demirgüç-Kunt, and Levine (2009) and Demirgüç-Kunt and Huizinga (19
τ^w	0.18	Payroll tax rate, based on Paes and Bugarin (2006)
τ^c	0.2343	Credit subsidy policy based on Sant'Anna, Borça-Junior, and de Araujo (2009)
B. Jointly calibrated parameters and statistics matched		
ζ	$2.15^* w_b$	Calibrated to match the percent of subsidized credit
ϵ	6.2	Entrepreneurial Gini index of 0.49, PNAD's Microdata
ϕ	0.22	7.56% of entrepreneurs in the population, PNAD's Microdata
γ	0.4	Total loans to output ratio, World Development Indicators
β	0.9510	Capital to output ratio equal to 2.2, Penn World Tables 6.2
B	0.3751	30% of aggregate capital is employed in the corporate sector

Table 4: Basic statistics, Brazil and baseline economy. Sources: Bech and Rice (2009), 2008 Brazilian households survey (PNAD), Sant'Anna, Borça-Junior, and de Araujo (2009), and World Development Indicators.

	Brazil	Baseline economy
Overhead and tax as perc. of total bank assets (%)	12	12
% of entrepreneurs (%)	7.59	7.54
Entrepreneurs' income Gini (%)	49.20	49.04
Share of capital in the corporate sector (%)	30	30
Capital to output ratio	2.2	2.13
Total loans to output ratio (%)	30	29.4
Fraction of subsidized loans	27	25.4

of entrepreneurial earnings corresponds to 49.5%;[20] about 30 percent of aggregate capital is employed in the corporate sector;[21] and total debt to production is about 33 percent of income. Table 4 reports the key statistics for the Brazilian and our model economy.

[20] This can be found using also the 2008 PNAD.

[21] We consider the corporate sector as all firms listed in the Brazilian stock market. According to data from the Brazilian stock market (BMF & BOVESPA, available at http://www.bmfbovespa.com.br/), total permanent assets of listed firms in Brazil is about 0.66 of GDP. Since the capital to output ratio is 2.2, this implies that about 30% of the capital is employed in the corporate sector in Brazil.

3.2.2 Quantitative Experiments

Now we implement some counter-factual exercises. We vary the level of credit subsidies and evaluate their quantitative implications on output per capita, wages, wealth inequality, fraction of subsidized loans, payroll tax rate and government finances. Figure 5 reports the results for an economy with an endogenous and exogenous interest rate. Notice that the effects - as well as in the United States case - are roughly the same with the two assumptions about the level of restrictions on capital flows.

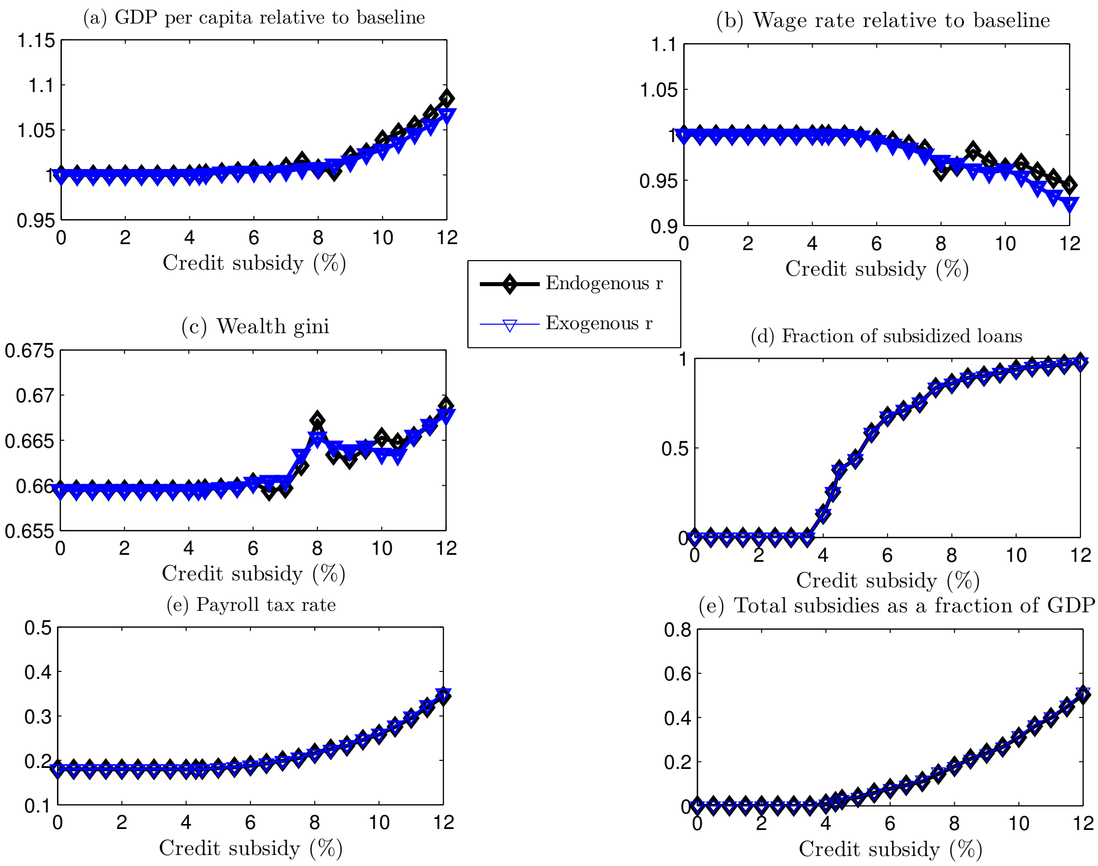

Figure 5: Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) Fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP.

Note that when we cut interest rate subsidies from its baseline level of 4.3 percentage points to zero, then output per capita, wages, inequality in wealth and government finances remain roughly the same. Although about 27 of all loans are subsidize, there are no quantitative impact on the economy. If, however, we increase the level of interest rate subsidies, then we start to observe some quantitative impacts on the variables considered in the analysis. Output per capita increases monotonically, but wages decrease. For instance, if interest credit subsidies increase from 4.3 percentage points to 10 percentage points, then output per capital increases by 3.87 percent and wages decrease by 3.65 percent. In this case almost all loans are subsidized (about 94 percent) and the payroll tax rate increases by 7.8 percentage points to finance this loan program.[22] This is an expensive program: total credit increases from 30 percent to 55 percent of income and subsidized credit goes from 7.5 percent to 52 percent of income. This implies that when subsidies increase from 4.3 to 10 percentage points per year (which implies 61 percentage points in 5 years), the total cost of the program goes from 1.76 percent of income to 31 percent of income.

Next, we implement different exercises. We kept τ^c at its baseline value of 4.3 percent and decreased the fixed cost such that the fraction of subsidized loans increases in the economy. This would be a policy that would expand the subsidized credit program and increase its efficiency. Note, however, that the payroll tax rate has to adjust to compensate the loss on revenues from the fixed cost ζ. When the fraction of subsidized loans increases from the baseline level to about 50 percent of output (experiment 1, part (a) of Table 5), then output and wages increase slightly. Inequality remains roughly the same as well as the share of the corporate sector in the economy. Total credit as a fraction of output increases by 2 percentage points. In experiments 2 and 3 on Table 5(a), we decreased further the fixed cost ζ such that the share of subsidized credit in the economy is about 70 and 90 percent of total credit, respectively. Notice that output and wages increase in both cases, though as the program expands the payroll tax rate has to increase with negative effects on labor demand. The point is that, given the level of interest rate credit subsidies an expansion of the program which decreases entry barriers might lead to an increase in output and wages, and therefore efficiency.

In the experiments so far we have assumed that financial intermediaries can still charge the same spread, η, in subsidized loans. However, for most credit lines provide by BNDES there is a cap of 4 percent on the spread that financial institutions can charge, determined by the *FGPC* (*Fundo de Garantia para a Promoção da Competitividade*). See BNDES (2010).[23] Given that, we have that the cost of loan by BNDES corresponds to: (i) the long run interest rate (TJLP - 6%); (ii) the basic spread charged by BNDES (roughly 1.73%); and (iii) the spread charged by financial institutions (up to 4%) or the risk premium fee (3.57%) charged by BNDES, when

[22]For low levels of interest rate subsidies, there is not much effect on the payroll tax rate because the income raised with the fixed cost (ζ) is sufficient to finance the program.

[23]Some of the BNDES loans are also made directly without the participation of financial intermediaries. In this case, BNDES also charges an additional risk premium fee of about 3.57 percent.

the credit operations are made directly without financial intermediaries. About 50 percent of all credit operations are made through financial intermediaries. The point is that the final cost of BNDES loans are in general around 11-12 percent, which is roughly similar to the interest rate set by Brazil's Central Bank. In this case, the credit subsidy is larger than what we had above in the previous calibration and τ^c is about 12 percent per year. In addition, since there is a cap on the interest rate spread which financial intermediaries can charge on subsidized loans, this implies that in the model they have to charge a higher rate on non-subsidized loans to compensate for any loss on subsidized loans. In this case, non subsidized loans will have a spread of:

$$r_b = r + \eta + (\eta - \bar{\eta}) \times 0.50 \times \frac{L^s}{L},$$

where $\bar{\eta} = 0.04$ corresponds to the cap on the spread rate that financial intermediaries can charge on subsidized loans (L^s).[24] Notice that the level of subsidized loans will affect the total spread as reported by Souza-Sobrinho (2010). In the baseline economy the total spread in non-subsidized loans is equal to 13.08 percent per year,[25] while subsidized loans have no spread relatively to the deposit rate.

We recalibrate the model parameters such that we match the same targets of Table 3, except for the policy parameter τ^c, which is now equal to 12 percent instead of 4.3 percent per year.[26] We then do the following counter-factual exercises. First, we cut all credit subsidies in the economy. This is reported in Table 5(b), row experiment 1. As in Figure 5 there is not a significative quantitative effect on per capita income, the wage rate and on the labor tax rate.[27] The only variable that changes significatively is the level of total credit, which increases by 3 percentage points, and the size of the corporate sector which decreases by 7 percentage points.

We then implemented the experiments in which we keep τ^c at its baseline value (in this case 12 percent) and decreased the fixed cost such that the fraction of subsidized loans increases in the economy. When the fraction of subsidized loans increases from the baseline level to about 50 percent of output (Table 5(b) experiment 2), then output and wages remain roughly the same, as well as inequality. Total credit as a fraction of output falls by 2 percentage points.[28] The share of the corporate sector

[24]We multiply it by 0.50 since about 50 percent of all loans provided by BNDES are made through financial intermediaries.

[25]This corresponds to the case in which $\eta = 0.12$, $\bar{\eta} = 0.04$, and $\frac{L^s}{L} = 0.27$.

[26]The value of the fixed parameters are the same as in Table 3. The value of the six jointly calibrated parameters are: $\zeta = 12.25^{*} w_b$, $\epsilon = 6.0$, $\phi = 0.225$, $\gamma = 0.4$, $\beta = 0.9510$, $B = 0.3753$.

[27]The fixed cost is high enough such that it is sufficient to finance the program.

[28]There are two effects on the share of total credit in the economy: First, a decrease in ζ is similar to an expansion of the subsidized credit program, which leads to an increase in total credit; but the spread rate charged on "market" loans increases, decreasing non-subsidized loans.

Table 5: Policy Experiments: Long run effects of credit subsidies. Economy with endogenous interest rate.

	Y per capita % of baseline	w % of baseline	% of entreprs.	K/Y	Entreprs.' income Gini (%)	Wealth Gini (%)	Credit output ratio (%)	% of subsid. credit	Size of corpor. sector	Progr. cost % of Y
	Part (a): First calibration - Brazil									
Baseline $\tau^w = 18\%$ ζ_b $\tau^c = 4.3\%$	100	100	7.54	2.13	49.0	66	29.4	25.4	30	1.76
Exper. 1 $\tau^w = 18.27\%$ $0.75\zeta_b$ $\tau^c = 4.3\%$	100.63	100.31	7.53	2.13	49	66	31	50	30	3.5
Exper. 2 $\tau^w = 18.68\%$ $0.56\zeta_b$ $\tau^c = 4.3\%$	100.74	100.41	7.52	2.13	49	66	32	70	30	5.1
Exper. 3 $\tau^w = 20.18\%$ $0.20\zeta_b$ $\tau^c = 4.3\%$	101.9	100.06	7.51	2.08	50.1	66	37	90	25	7.8
	Part (b): Second calibration - Brazil									
Baseline $\tau^w = 18\%$ ζ_b $\tau^c = 12\%$	100	100	7.79	2.11	48.9	66.2	27	26	30	5.26
Exper. 1 $\tau^w = 18\%$ ζ_b $\tau^c = 0$	100.17	100.09	7.8	2.00	48.95	66.3	30	0	22.4	0
Exper. 2 $\tau^w = 18.59\%$ $0.75\zeta_b$ $\tau^c = 12\%$	100.71	99.71	7.79	2.24	49	66.1	25	50	35	9.10
Exper. 3 $\tau^w = 19.33\%$ $0.56\zeta_b$ $\tau^c = 12\%$	100.01	98.76	7.79	2.25	49.3	66	24	70	37	12
Exper. 4 $\tau^w = 25\%$ $0.20\zeta_b$ $\tau^c = 12\%$	102.7	97.64	7.73	2.53	51	66	32	90	43	22

in the economy increases from 30 to 35 percent. In experiment 3 on Table 5(b), we decreased further the fixed cost ζ such that the share of subsidized credit in the economy is about 70 percent of total credit. Notice that output remains roughly the same, while wages decrease by only 1.2 percent. The payroll tax rate increases by roughly 1.33 percentage points to finance more subsidized loans. Notice that credit to output ratio is about 24 percent of income. There are more subsidized loans and non-subsidized loans have a spread of about 14.8 percent relatively to the baseline deposit rate. Finally in experiment 4, Table 5(b), we decreased ζ such that about 90 percent of all loans are subsidized. In this case, output increases by 2.67 percent, while wages decrease by roughly 2.3 percent. Notice that the payroll tax rate has to increase by 7 percentage points relatively to the baseline economy to finance the credit program, which explains the decrease in the wage rate. Inequality increases and the share of credit in income increases by 5 percentage points relatively to the baseline.

4 Concluding remarks

This paper studies the effects of interest rate credit subsidies on economic development in a general equilibrium model with occupational choice and financial frictions. We show that for the United States, interest rate credit subsidies do not have significant effect on output per capita, but it can have important negative effects on wages and government finances. These subsidies can be viewed as a transfer from workers to a small measure of entrepreneurs.

For Brazil, a country in which financial repression is high and the government subsidies heavily loans provided by its main development bank (BNDES), our counter-factual exercises show that if the country cut all interest subsidies, then there will not be any important quantitative effect on output per capita, wages, inequality and government finances. This suggests that subsidized loans have not been effective to decrease the misallocation problem due to strong financial frictions in Brazil. However, we also show that if the country increases interest rate subsidies, then output per capita would increase, while wages would decrease by almost the same percentage change. An interesting result, however, is when we keep interest rate subsidies at the level observed in Brazil, but we increase access to such credit program (decrease the entry barriers to participate in this program), then output and wages might both increase as long as the effects on the payroll tax rate are not large enough and the interest rate subsidies do not not affect directly the spread on non-subsidized loans.

Therefore, our quantitative exercises for both the United States and for Brazil (as well as the empirical evidence) suggest that rather than providing interest rate subsidies to address the problem of misallocation and to increase productivity, countries should focus on financial reforms that would improve the functioning of the financial and credit markets, such as reforms that increase creditor's protection, decrease asymmetric problems and intermediation costs. In developing countries with a high level of financial repression, such reforms might have sizeable impact on development, while, in general, interest rate credit subsidies function as a transfer from workers to entrepreneurs and can be only justified by political purposes.

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A Additional tables

Table 6: Policy Experiments: Long run effects of credit subsidies. Economy with endogenous interest rate.

	Y per capita, % of baseline	w, % of baseline	% of entreprs.	K/Y	Entreprs.' income Gini (%)	Wealth Gini (%)	Yearly r %	Program cost over Y (%)	% of subsidiz credit
Baseline	100	100	7.49	2.51	45.02	39.28	4.47	0	0
Part (a): No fixed cost, $\zeta = 0$									
$\tau^c = 1\%$ per year, $\tau^w = 34.4\%$	100.06	99.56	7.75	2.52	46.01	39.45	4.4	1.76	100
$\tau^c = 2\%$ per year, $\tau^w = 36\%$	101.23	98.96	7.76	2.54	46.06	40.71	4.32	3.85	100
$\tau^c = 3\%$ per year, $\tau^w = 37.9\%$	100.08	97.93	7.79	2.40	47.11	43.65	4.28	6.85	100
$\tau^c = 3.927\%$ per year, $\tau^w = 40\%$	101.29	97.09	7.93	2.48	47.46	44.5	4.25	9.61	100
Part (c): Positive fixed cost, $\zeta = 0.1w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 34.04\%$	100.11	99.42	7.49	2.66	45.52	39.32	4.46	1.40	77.25
$\tau^c = 2\%$ per year, $\tau^w = 35.76\%$	100.54	98.60	7.49	2.67	46.02	39.62	4.40	3.73	94.01
$\tau^c = 3\%$ per year, $\tau^w = 37.79\%$	100.56	96.49	7.53	2.58	46.46	42.90	4.49	6.69	100
$\tau^c = 3.927\%$ per year, $\tau^w = 39.88\%$	101.59	95.98	7.65	2.58	47.73	43.42	4.36	9.71	100
Part (c): Positive fixed cost, $\zeta = 0.2w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33.2\%$	100.4	100.01	7.49	2.51	45.42	39.34	4.46	0.92	54.47
$\tau^c = 2\%$ per year, $\tau^w = 34.1\%$	100.36	99.72	7.48	2.51	46.16	39.66	4.41	3	81.27
$\tau^c = 3\%$ per year, $\tau^w = 35.5\%$	100.99	99.39	7.49	2.52	47.28	40.28	4.31	5.72	93.02
$\tau^c = 3.927\%$ per year, $\tau^w = 37.4\%$	100.53	98.22	7.5	2.42	47.52	41.17	4.29	9.18	98.31
Part (d): Positive fixed cost, $\zeta = 0.4w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33\%$	99.94	100.07	7.49	2.51	45.16	39.2	4.46	0.3	18.23
$\tau^c = 2\%$ per year, $\tau^w = 33.4\%$	100.21	100	7.49	2.51	45.81	39.41	4.43	2.21	59.15
$\tau^c = 3\%$ per year, $\tau^w = 34.4\%$	100.72	99.85	7.48	2.51	46.92	39.87	4.36	4.52	76.52
$\tau^c = 3.927\%$ per year, $\tau^w = 35.8\%$	101.11	99.31	7.49	2.52	47.9	42.9	4.43	7.38	86.9
Part (d): Positive fixed cost, $\zeta = 0.6w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33\%$	100	100	7.49	2.51	45.02	39.28	4.47	0	0
$\tau^c = 2\%$ per year, $\tau^w = 33.1\%$	100.12	100.15	7.49	2.51	45.55	39.31	4.45	1.45	41.17
$\tau^c = 3\%$ per year, $\tau^w = 33.7\%$	100.55	100.07	7.48	2.51	46.51	39.72	4.39	3.62	63.26
$\tau^c = 3.927\%$ per year, $\tau^w = 34.9\%$	100.88	99.57	7.47	2.53	47.65	40.19	4.35	6.28	76.43

Table 7: Policy Experiments: Long run effects of credit subsidies. Economy with exogenous interest rate.

	Y per capita, % of baseline	w, % of baseline	% of entreprs.	K/Y	Entreprs.' income Gini (%)	Wealth Gini (%)	Yearly r %	Program cost over Y (%)	% of subsidiz credit
Baseline	100	100	7.49	2.51	45.02	39.28	4.47	0	0
Part (a): No fixed cost, $\zeta = 0$									
$\tau^c = 1\%$ per year, $\tau^w = 34.4\%$	100.20	98.71	7.75	2.45	46.01	40.30	4.47	1.83	100
$\tau^c = 2\%$ per year, $\tau^w = 36\%$	100.93	97.55	7.76	2.38	46.46	41.51	4.47	4.11	100
$\tau^c = 3\%$ per year, $\tau^w = 37.9\%$	101.59	96.22	7.94	2.29	47.05	42.76	4.47	6.99	100
$\tau^c = 3.927\%$ per year, $\tau^w = 40\%$	101.16	94.82	7.96	2.28	47.58	45.72	4.47	10.05	100
Part (c): Positive fixed cost, $\zeta = 0.1w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33.4\%$	100.02	99.45	7.63	2.49	45.87	39.67	4.47	1.40	79.51
$\tau^c = 2\%$ per year, $\tau^w = 34.80\%$	100.45	98.52	7.63	2.45	46.87	40.53	4.47	3.67	93.82
$\tau^c = 3\%$ per year, $\tau^w = 36.60\%$	101.18	97.22	7.75	2.36	47.64	41.90	4.47	6.71	100
$\tau^c = 3.927\%$ per year, $\tau^w = 38.7\%$	102.26	95.77	7.67	2.27	47.34	43.73	4.47	9.91	100
Part (c): Positive fixed cost, $\zeta = 0.2w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33.2\%$	99.96	99.66	7.63	2.49	45.66	39.49	4.47	0.94	54.33
$\tau^c = 2\%$ per year, $\tau^w = 34.1\%$	100.28	99.01	7.63	2.46	46.69	40.16	4.47	3.07	80.98
$\tau^c = 3\%$ per year, $\tau^w = 35.6\%$	100.85	97.93	7.75	2.38	48.08	41.24	4.47	5.97	92.65
$\tau^c = 3.927\%$ per year, $\tau^w = 37.4\%$	101.71	96.58	7.76	2.29	48.65	42.56	4.47	9.44	97.98
Part (d): Positive fixed cost, $\zeta = 0.4w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33\%$	99.89	99.81	7.75	2.48	45.84	39.4	4.47	0.39	23.11
$\tau^c = 2\%$ per year, $\tau^w = 33.4\%$	100.13	99.47	7.63	2.47	46.16	39.76	4.47	2.15	57.66
$\tau^c = 3\%$ per year, $\tau^w = 34.42\%$	100.42	98.73	7.75	2.42	47.72	40.43	4.47	4.65	76.27
$\tau^c = 3.927\%$ per year, $\tau^w = 35.9\%$	100.99	97.71	7.76	2.36	48.70	41.35	4.47	7.83	87.26
Part (d): Positive fixed cost, $\zeta = 0.6w_{baseline}$									
$\tau^c = 1\%$ per year, $\tau^w = 33\%$	100.12	99.80	7.76	2.37	45.80	39.54	4.47	0.15	8.67
$\tau^c = 2\%$ per year, $\tau^w = 33.1\%$	100.04	99.70	7.63	2.48	45.76	39.51	4.47	1.47	40.97
$\tau^c = 3\%$ per year, $\tau^w = 33.8\%$	100.42	99.19	7.75	2.42	47.52	40.27	4.47	3.77	63.39
$\tau^c = 3.927\%$ per year, $\tau^w = 34.9\%$	100.83	98.40	7.75	2.38	48.54	40.93	4.47	6.70	77.53