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Antonio Antunes
Tiago Cavalcanti
Anne Villamil

Antonio Antunes
Departamento de Estudos Econômicos
Banco de Portugal
antunesaa@gmail.com

Tiago Cavalcanti
Faculty of Economics   Programa de Pós-Graduação em Economia
University of Cambridge   Universidade Federal de Pernambuco (PIMES/UFPE)
Sidgwick Avenue
Cambridge - CB3 9DD - England
tvdvc2@cam.ac.uk

Anne Villamil
Department of Economics   Stanley Jevons Professor of Economics
University of Illinois Urbana-Champaign   University of Manchester
avillami@illinois.edu

The Effects of Credit Subsidies on Development[*]

António Antunes[†]   Tiago Cavalcanti[‡]   Anne Villamil[§]

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Abstract

This paper evaluates the effects of a subsidy on loan interest rates in a general equilibrium model with heterogeneous agents, occupational choice and two financial frictions: a cost to intermediate loans and imperfect enforcement of credit contracts. Occupational choice and firm size are determined endogenously by an agent's type (ability and net wealth) and the credit market frictions. The credit program subsidizes the interest rate on loans and requires a fixed application cost, which might be null, in the form of bureaucracy and regulations. We show that for the United States, this 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, 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. The program is largely a transfer from workers to a small group of entrepreneurs.

KEYWORDS: Financial frictions; Subsidized credit; Occupational choice; Development;
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[†]Departamento de Estudos Económicos, Banco de Portugal. Email: antunesaa@gmail.com
[‡]Faculty of Economics, University of Cambridge and PIMES-UFPE. Email: tvdvc2@cam.ac.uk.
[§]Department of Economics, University of Illinois Urbana-Champaign and University of Manchester. Email avillami@illinois.edu

1   Introduction

When markets function perfectly inequality reflects differences in effort, innate ability to acquire skills, manage a labor force, or deploy capital. Even when initial wealth is unequal, more talented entrepreneurs with low initial wealth will borrow to acquire capital (if entrepreneurial talent is complementary to capital in production), offsetting their initial disadvantage relative to less talented counterparts with high initial wealth. In the limit, the credit market equalizes the marginal products of capital among entrepreneurs and allocations are optimal. In contrast, when credit markets are imperfect due to screening costs, information problems, limited liability or other frictions, marginal products generally are not equal and underinvestment can occur. High ability but low initial wealth entrepreneurs have higher marginal products of capital relative to low ability but high initial wealth entrepreneurs, resulting in lower equilibrium output and perpetuating inequality.

This capital market failure provides a rationale for policies to reduce allocative inefficiency. Policy-makers also sometimes motivate intervention as an attempt to redress the perceived "unfairness" of problems linked to the distribution of initial wealth, since one's assignment in this distribution is an accident of birth.[1] In this paper we study one common policy intervention, interest rate subsidies on loans, designed to improve access to credit. Although well intentioned, we show that this policy is not an effective way to reduce the problems caused by capital market frictions. Under plausible calibrations in a general equilibrium occupational choice model, we show that a policy modelled in accordance with one used by a development bank, has no significant effect on output, reduces wages, and is largely a transfer from workers to a small group of entrepreneurs.

Quantitative macroeconomics has been used extensively to study the effects of financial (institutional) reforms designed to correct credit market imperfections. Among the reforms studied are improvements in creditor protection, changes in bankruptcy law, or decreases in implicit and explicit taxes on banks. Recent examples of the quantitative effects of such reforms in macroeconomic models are: Amaral and Quintin (2010), Antunes and Cavalcanti (2007), 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 can have sizeable effects on efficiency, development, tax evasion and inequality and the effects are stronger when the economy is financially integrated in the interna-

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[1]There is no market to choose one's family, yet this decision by nature has a profound effect on one's opportunities in life.

tional capital market.[2]

In this paper we study a related but different question to the existing literature on the quantitative effects of financial reform. Given the institutional level of a particular economy (strength of creditor 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, we evaluate the consequences of credit subsidies, a standard way to address underinvestment, on measures of development, inequality and government finances, in a general equilibrium model of economic development with heterogeneous agents and financial frictions *à 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 a given entrepreneurial ability and initial wealth, and lives for J periods. A measure one of each cohort leaves the economy and is replaced by an equal measure of agents each period. Agents value consumption in each period of their life and a 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 that maps into the degree of credit contract enforcement. Occupational choice and firm size are determined endogenously by an agent's type (ability and net wealth) and the credit market frictions. A credit program subsidizes the interest rate on loans, with a fixed cost (which might be null) to apply for subsidized loans, in the form of bureaucracy and regulatory compliance. The credit program is financed by income from the fixed cost and a payroll tax.

Intuitively, when the government subsidizes the loan rate, entrepreneurs increase their demand for loans for a given interest rate. If the economy is small and financially integrated in the world market, then the interest rate will not change. The policy would increase capital accumulation and production. However, the tax rate must increase to satisfy the government budget constraint, which decreases labor demand and production. In addition, if there are restrictions on capital flow, the demand effect will push interest rates up. The general equilibrium supply effect would decrease the profitability of entrepreneurial activity. The aggregate impact of credit subsidies on development is not clear, and we use numerical methods to solve the model and conduct counter-factual experiments.

Credit allocation and preferential interest rate policies are tools used by many governments, including, for instance, the United States Small Business Administration loan subsidy program. Such programs are especially common in developing

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[2]See Caselli and Gennaioli (2008), Rajan and Zingales (2003a),Rajan and Zingales (2003b), among others, to understand why some of these reforms are not implemented.

countries, such as South Korea (Lee, 1996) and Brazil (Ribeiro and DeNegri, 2010, Souza-Sobrinho, 2010). Brazil's National Development Bank (BNDES) provides subsidized credit, accounting for about 27 percent of all productive credit in the country. The subsidized interest rate is much lower than the "market" rate on credit loans to firms, sometimes as low as the basic Central Bank interest rate in Brazil (see section 3.2). BNDES provides credit mostly through commercial and regional development banks, raising resources mainly from compulsory contributions from workers and loans from the Brazilian Treasury at a rate below 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 lent to BNDES at rate of roughly 6 percent.[3]

Loan rate subsidies are used by many countries, but not much has been written on the aggregate effects of this policy on allocations and development in a quantitative macro model with entrepreneurs and financial frictions. An older literature built the foundations of the effects of credit subsidies on economies with financial frictions and credit rationing, e.g., de Meza and Webb (1988) and Smith and Stutzer (1989).[4] In work more related to ours, Gale (1991) uses a modified version of the Stiglitz and Weiss (1981) model to study quantitatively the effects of credit programs. He conducts a static, partial equilibrium analysis, while our model is dynamic with all prices determined endogenously. Li (2002) also investigates the effects of credit subsidies in a model with entrepreneurs and occupational choice, but with a different policy: the government targets some entrepreneurs and repays a fraction of their non-collateralized loans, a type of loan guarantee program that has been used in the United States. Our policy has subsidized and non-subsidized interest rates with a given fixed cost to apply for subsidized loans, and entrepreneurs endogenously self-select loans.[5] Both Gale and Li focus on the United States. We also apply our model to Brazil, a developing country with significant financial repression where subsidized loans account for a sizeable fraction of total credit.

Our simulations indicate that credit subsidies do not have a strong effect on

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[3]The final interest rate on BNDES loans also contains a spread charged by BNDES and a financial intermediary spread. See section 3.2, Ribeiro and DeNegri (2010) and Ottaviano and de Sousa (2008), for more details about how BNDES operates and its credit lines.

[4]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. Stiglitz (1994) discusses the foundation of different government interventions in financial markets, including credit subsidies.

[5]Our models also differ regarding how we model financial frictions. Besides the intermediation costs, we have an enforcement constraint that the subsidized loan program affects by decreasing loan interest rates. We also have a corporate sector, as in Quadrini (2000) and Wynne (2005), where the credit market frictions may not bind. This is important since large corporations account for a significant fraction of output and do not face the same credit frictions as small entrepreneurs.

output in the United States. For instance, when all credit is subsidized, and the subsidy is such that there is no spread between the deposit and the borrowing rates (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, payroll taxes increase significantly. When there are entry costs to apply for the subsidy, then the effects on the economy are quantitatively smaller. Therefore, our results show that the effect of credit subsidies on aggregate efficiency is small, but they have an important impact on government finances and distributional effects. The results are quantitatively similar when we consider an economy completely integrated in the international financial market and interest rates are exogenously given.

The case of a developing economy, calibrated to Brazil, yields different and interesting results. In counter-factual exercises in which all interest subsidies are cut, there is no significant effect on output, wages, inequality or government finances. This implies that subsidized loans are not an effective way to improve allocations. 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. The payroll tax must increase significantly and there is a distributional effect as in the United States. Interestingly, when we keep interest rate subsidies at the level currently observed in Brazil, but increase access to the credit program by decreasing the fixed cost, then output and wages might both increase as long as the payroll tax effect is not too large. Therefore, given an interest credit subsidy program, expanding access by reducing entry costs might lead to higher long run output, wages and welfare.

Our model simulations are consistent with empirical evidence on interest credit subsidies and development. Using manufacturing industry data, Lee (1996) shows that cheap credit programs 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 discontinuities in 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.[6] While our results are consistent

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[6]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.

with these econometric analyses, our general equilibrium model makes clear the underlying forces that drive the outcomes.

The 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 concluding remarks.

2 The Model

2.1 Environment

The economy has 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 so 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. The model is similar to Antunes, Cavalcanti, and Villamil (2008b) with the following important differences. First, in Antunes, Cavalcanti, and Villamil (2008b) there is only one type of credit, while here there are two types, subsidized and non-subsidized. Second, in Antunes, Cavalcanti, and Villamil (2008b) agents live for only one period, while here they live for J periods. This increases the possibility of internal finance, which might be important in evaluating the effects of credit policies on development. We do sensitivity analysis with respect to J.

2.1.1 Endowments

In the beginning of life, each agent is endowed with initial wealth, b_t, inherited from the previous generation. 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 lifetime talent for managing, x, drawn from a continuous cumulative probability distribution function $\Gamma(x)$ where $x \in [0, 1]$. Agents accumulate assets, $\{a_t^j\}_{j=1}^J$ and are distinguished by their age, assets and ability as entrepreneurs each period, (j, a_t^j, x_t), with $a_t^1 = b_t$. We assume that an agent's talent for managing is not hereditary. We also assume that type is public information, but loans cannot be made contingent on this information.

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2.1.2 Households

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

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

$\beta \in (0,1)$ is the subjective discount factor, $\sigma > 0$ denotes the inverse of the elasticity of intertemporal substitution, and $\gamma > 0$ denotes the altruism factor.

When $J = 1$ households are similar to those in Banerjee and Newman (1993) and Galor and Zeira (1993). When $J \to \infty$, households are infinitely lived, as in the Banerjee and Moll (2010) occupational model. Banerjee and Moll (2010) show that financial frictions do not have a long run effect on output when the technology exhibits decreasing returns to scale in traded inputs (e.g., capital and labor) because over time households can self-finance capital and do not need to rely on borrowing to undertake projects. For financial frictions to have long run effects either entrepreneurial ability x must change over time (as in Buera and Shin, 2008) or agents must be finitely lived (e.g., Antunes, Cavalcanti, and Villamil, 2008b). In order to save notation we drop subscript t.

2.1.3 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:

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

Corporate firms do not face the same financial restrictions as firms in the entrepreneurial sector because large corporate organizations are not subject to the same enforcement and incentive restrictions. This implies that corporate firms can 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.

2.1.4   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.

2.1.5   Financial intermediaries

Financial intermediaries face a cost η for each unit of capital intermediated. Parameter η reflects transaction costs such as bank operational or regulation costs (e.g., reserve and liquidity requirements). We do not model η explicitly and take it as given.[7] 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,

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

while the rate on the remainder is r_B. Competition among banks implies that the effective interest rate on borrowing is $r_B = r + \eta$.[8]

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 an incentive compatible contract to make it in the borrower's self-interest to repay.

2.1.6 Government

A government raises revenue through a payroll labor tax, τ^w, to finance exogenously given government spending, g, and to subsidize credit,[9] so that the borrowing rate on subsidized credit is $r_B - \tau^c$. We assume that interest rate subsidies are not made directly from the government to entrepreneurs. Banks handle all intermediation in the economy and the government subsidizes some of the loans. Subsidized and non-subsidized loans face similar institutional problems (a limited liability constraint). We assume that g does not change with changes in credit policy.[10] For entrepreneurs to raise subsidized capital, they must 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 credit receives the same government subsidy.

Notice that we are assuming that ζ is a fixed cost that is similar among all entrepreneurs. Using indicators of political connections constructed from campaign contribution data, Claessens, Feijen, and Laeven (2008) show that Brazilian firms that provided contributions to (elected) federal deputies experienced higher stock returns than firms that did not around the 1998 and 2002 elections. In addition, they also show that access to bank finance is an important channel through which political connections operate.[11] Finally, the authors also find that firms that contributed more in the elections had lower economic performance and they interpret these contributions as a firm survival strategy. Since we abstract from political connection, our results are an upper bound of the effects of credit subsidies on development.

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[8]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.

[9]We set $\tau^k = 0$ for two reasons: (i) the overall goal of the program is to expand access to capital, and (ii) this is consistent with the credit program in Brazil we will analyze. As a consequence, our results will provide a lower bound on the distortionary effects of this credit policy.

[10]The only role for g is to balance the budget constraint in the baseline economy. Given the value for τ^w, consistent with some data statistics, g is chosen such that the government budget constraint in the baseline economy is in equilibrium. We vary the credit interest policy, and then adjust τ^w to balance the government budget constraint, keeping the value of g at its baseline level.

[11]The effects of political connectedness on access to finance are also corroborated by Sapienza (2004) and Khwaja and Mian (2005).

2.1.7 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 non-subsidized and subsidized credit, respectively, and w is the wage rate. The problem of a household can be written as:

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

subject to

$$c^j + a^{j'} \leq W(x, a^j; w, r) + (1+r)a^j + tr, \qquad (7)$$

$$W(x, a^j; w, r) = \max\{w, \max\{V^{ns}(x, a^j; w, r), V^s(x, a^j; w, r)\}\}, \qquad (8)$$

$$c^j, a^{j'}, b^{J+1} \geq 0, \; j = 1, ...J, \text{ and } a^{J'} = b^{J+1}, \; a^1 = b. \qquad (9)$$

Equation (7) is the household's budget constraint, with income $W(x, a^j; w, r)$ and transfers tr. Equation (8) implies that households choose an occupation to maximize income. Condition (9) states choice variable constraints and initial conditions.

2.1.8 Entrepreneurs

Households with sufficient resources and managerial ability to become entrepreneurs choose the level of capital and 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:

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

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

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

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. 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. The loan size depends on whether 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 all their assets in the firm as long as $d \leq k^*(x; w, r)$, where $k^*(x; w, r)$ corresponds to the problem of an unconstrained firm. Therefore, $l^h(a^j, x; w, r) = 0$ for $a^j \geq k^*(x; w, r)$, which follows immediately from the fact that the cost of self-financing is lower than using a financial intermediary. Moreover, for credit constrained entrepreneurs, $l^h(a^j, x; w, r)$ is increasing with both x and b.

2.1.9 Occupational choice

The occupational choice of each agent determines income. Define $\Omega = [0, \infty) \times [0, 1]$. For any $w, r > 0$, 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

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

The following Lemma applies:

Lemma 1 *Define $a_e^j(x; w, r)$ as the curve in Ω where $\max\{V^{ns}(a^j, x; w, r), V^s(a^j, x; w, r)\}$ equals 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). ∎

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 to determine 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 section 3.1 where $\zeta = 0.2w$ and $\tau^c = 1\%$ per year. Lemma 1 and figure 1 indicate that agents are workers when their entrepreneurial ability 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.

Figure 1: Occupational choice.

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

In order to investigate the effects of credit subsidies on occupational choice, firm size, borrowing, output and prices we must solve this general equilibrium model numerically. We first define an equilibrium.

2.2 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

with 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:

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

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

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

$$\sum_{\substack{j=1 \\ z \in E^s(w,r)}}^{J} \iint \tau^c l(x, a^j; w, r)\Upsilon(da^j)\Gamma(dx) + g = \sum_{j=1}^{J} [\iint_{\substack{z \in E(w,r)}} \tau^w wn(x, a^j; w, r)\Upsilon(da^j)\Gamma(dx) \tag{20}$$

$$+ \iint_{\substack{z \in E^s(w,r)}} \zeta \Upsilon(da^j)\Gamma(dx)].$$

We assume that bureaucracy cost ζ is used to finance the organizational structure to manage the subsidized loan program. 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 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, assume that intermediation cost, η, is redistributed back to households:

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

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 must assign values 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

The baseline model is calibrated so that the long run equilibrium matches some key statistics of the U.S. economy. We assume that $J = 9$ and each model period is 5 years.[12] 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 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 for technology $(\theta, B, \nu, \alpha, \delta, \epsilon)$, three for utility (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. Below we describe in the detail how we assign each value.

We set ν and α so that in the entrepreneurial sector 55% of income is paid to labor, 35% is paid to remunerate capital, and 10% are profits.[13] 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%, consistent with Gollin (2002). We assume that the capital stock depreciates at a rate of 6% per year, 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, 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

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[12]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 used in the baseline.

[13]This is consistent with Gollin (2002).

Table 1: U.S. 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)

the average from 1999 to 2008 of banks' non-interest 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 is $\eta = 0.03927$. We set $\tau^w = 0.33$ to match the average tax rate on labor income in the United States (c.f., Jones, Manuelli, and Rossi, 1993). We first consider an economy with no credit subsides: $\tau^c = 0$ 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 so 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;[14] 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% 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).

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[14]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 and estimate it to be 2.55. The value for β is 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 model
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 1.8 and that corporations are the leading institutions of capital ownership. If we assume that most capital in the corporate sector is intermediated by either financial institutions, or by issuing bonds and stocks, our measure of intermediated capital is 1.83. The measure of intermediated capital in the entrepreneurial sector is about 34.1% of output. Finally, the model does not match the wealth Gini well: the model predicts roughly 39%, while the data is 78% (see Castañeda, Díaz-Giménez, and Ríos-Rull, 2003). Every worker receives the same equilibrium wage rate in the model economy, while in the data there is much more labor heterogeneity.[15]

3.1.2 Quantitative Experiments

We now explore numerically 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 provide a detailed table and explore the effects of credit subsidies on the following additional variables: the capital to output ratio, the fraction of entrepreneurs in the economy, the interest rate and entrepreneurs'

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[15]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.

income Gini. All statistics correspond to the stationary equilibrium of the model.

Figure 2 describes the model's predictions as the value of the credit subsidy changes from 0 to a value such that the borrowing and deposit rates are the same. We evaluate the effects for different values of fixed cost ζ, varing ζ from 0 (black solid line with a diamond marker) - the case in which all loans receive subsidies - to 60% of the baseline wage (blue solid line with a triangle marker) - the case in which subsidized loans are selected endogenously. Results for intermediate values of ζ are displayed in the grey dotted lines. When τ^c rises entrepreneurs increase the demand for loans for a given interest rate. This is a demand effect. If the economy is small and financially integrated in the world market, then the interest rate will not change. But if there are restrictions on 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, the impact of credit subsidies on development is unclear. Notice also that the payroll tax rate must increase to balance the government budget constraint, which decreases labor demand and production.

Figure 2(a) shows that in the baseline model, credit subsidies do not have a strong quantitative effect on output. When there is no fixed cost and credit subsidies increase from $\tau^c = 0$ to $\tau^c = 3.927\%$ per year, output per capita increases by less than 2% in the long run;[16] the wage rate decreases by about 3%; and wealth inequality increases. The Gini coefficient for household 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, the effects of credit subsidies on all variables are similar to the baseline case where $\zeta = 0$ but, in general, are quantitatively smaller; the positive effect on output and the negative effects on wages and government finances remain. Loan selection is endogenous and not all entrepreneurs benefit from the program. Our results show that the effects of credit subsidies on GDP are small, but they have non-negligible impacts on government finances and important distributional effects. Aggregate output does not change much, but there is an important compositional change: income is transferred from workers to entrepreneurs, where the latter remain a small part of the total labor force.[17]

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[16]When $\zeta = 0$ the largest effect is at $\tau^c = 2.5\%$ per year: output per capita increases by 1.81%.

[17]In the data, entrepreneurs are 7.5% of the labor force. In the experiment the share of entrepreneurs increases only slightly with credit subsidies: in the baseline with no fixed costs, it goes from 7.49% to 7.93% when credit subsidy τ^c changes from 0 to 3.927% per year. See panel (a) in table 6 in appendix A.
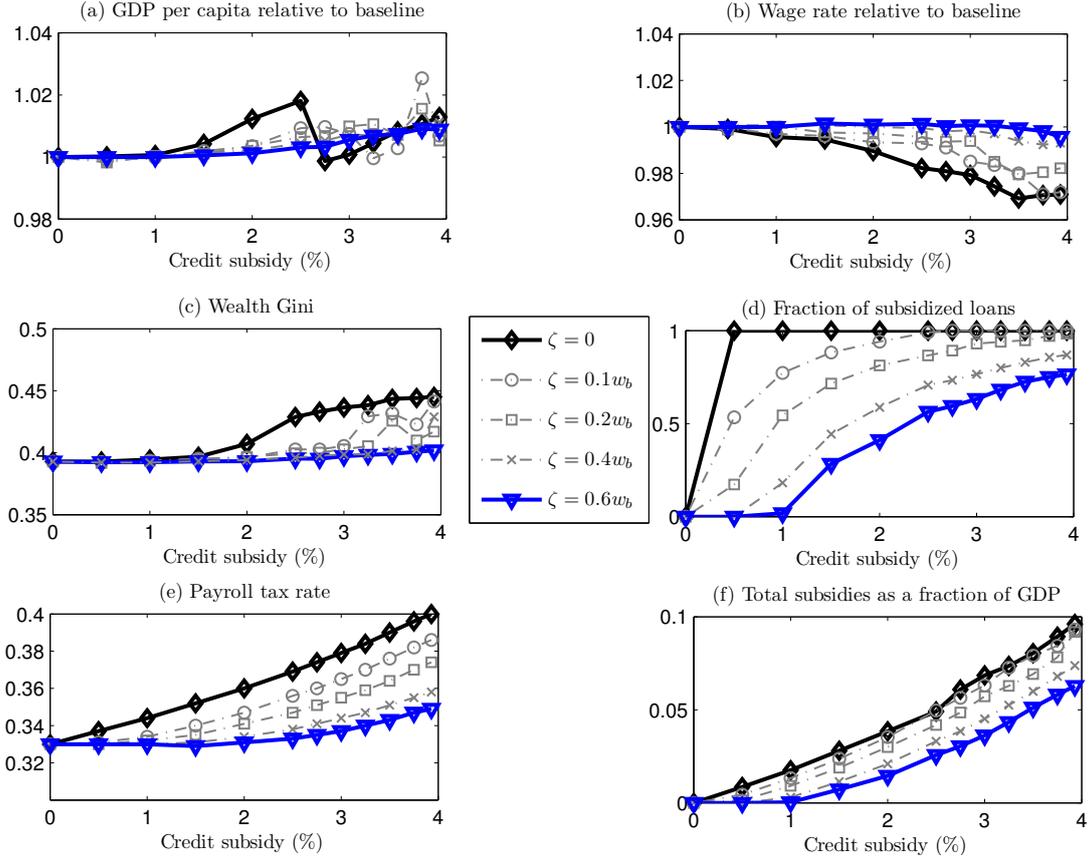
Figure 2: Economy with endogenous interest rate. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP. Different lines correspond to economies with different levels of the fixed cost, ζ.

In order to investigate whether or not the general equilibrium effect offsets the demand effect of credit subsidies, we also consider an economy that is financially integrated in international capital markets. In this case, financial intermediaries have access to an elastic supply of funds and the interest rate is exogenously given; 4.47% per year in the baseline economy. The effects of credit subsidies can differ greatly when the interest rate is exogenous or endogenous, see Castro, Clementi, and MacDonald (2004) and Antunes, Cavalcanti, and Villamil (2008b) where the general equilibrium effect is quantitatively important in analyses of financial reforms that improve creditors' rights. Figure 3 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 deposit rates are the same for different levels of the fixed cost (see also table 7 in appendix A).

Figure 3 shows that the relationship between the selected variables and credit

subsidies has the same pattern whether the interest rate is endogenous or exogenous. The output effect is slightly stronger than in the case with an endogenous interest rate, but the quantitative difference is small. The maximum effect on output occurs when $\tau^c = 3.927\%$ per year and the fixed cost, ζ, is 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.[18] Overall there is no major quantitative difference and the interest rate does not change much, see table 6 in appendix A.[19]

3.2 Brazil

3.2.1 Calibration

Now we calibrate the model economy so 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 is to provide quantitative measures of the effects of changing credit subsidy policies in Brazil. We do not investigate why policies differ between the two economies, rather we take policies as given and study the implications for development.

We keep $J = 9$ and continue to assume that the model period is 5 years. As before, we must 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. Thus, we use the same values in table 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 is the same in Brazil and in the United States.[20] 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

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

[19]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.

[20]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.
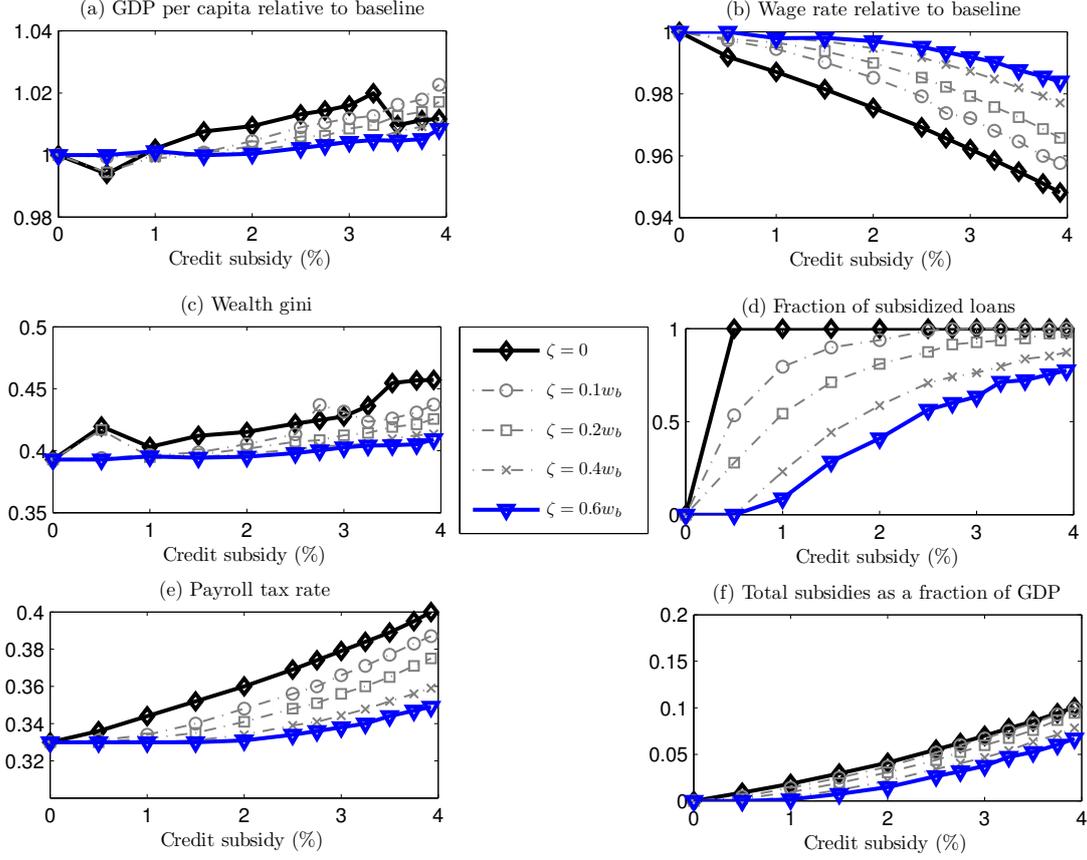
Figure 3: Economy with exogenous interest rate. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) Fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP. Different lines correspond to economies with different levels of the fixed cost, ζ.

total assets paid by banks is roughly 1 percent. Therefore, we set η such that the annual value of intermediation costs is 12 percent.[21] We set the payroll effective tax rate to $\tau^w = 0.18$, reported by Paes and Bugarin (2006) for the Brazilian economy.

We now set the value for policy parameter τ^c and institutional parameter ζ. Brazilian public banks provide about 30 percent of all credit in the country, but not all of this credit is subsidized. The Brazilian National Development Bank (BNDES) is the main supplier of subsidized credit and it also provides funding for 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. The World Development Indicators reports that private credit over output in Brazil has been growing recently and in 2008 it reached about 50 percent of GDP. However, not all loans

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

Table 3: Brazil 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, Gollin (2002)
α	0.39	Capital share in entrepreneurial activities, Gollin (2002)
θ	0.40	Capital share in the corporate sector, Gollin (2002)
δ	0.2661	Yearly depreciation rate of 6%
η	0.7623	Banks' overhead costs and taxes divided by total assets,
		Beck, Demirgüç-Kunt, and Levine (2009) and Demirgüç-Kunt and Huizinga (1999)
τ^w	0.18	Payroll tax rate, Paes and Bugarin (2006)
τ^c	0.2343	Credit subsidy policy, Sant'Anna, Borça Junior, and de Araujo (2009)
		B. Jointly calibrated parameters and statistics matched
ζ	$2.15w_b$	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

go to firms. Sant'Anna, Borça Junior, and de Araujo (2009) report that about 35 percent of the total credit in Brazil finances either family consumption or housing. Therefore, credit to production is about 30 percent of income and BNDES loans account for about 27 percent of all productive credit. We thus calibrate ζ so 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 below 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 lent to BNDES at about 6 percent. BNDES has no branches and it provides credit mostly through commercial and regional development banks,[22] which access BNDES resources at low rates that they pass on to firms. The final component in BNDES credit lines is an interest rate spread charged by BNDES of about 1.73 percentage points in 2009-2010 (average value, see BNDES, 2010) and a financial intermediaries spread.[23] Therefore, we assume that BNDES provides an annualized interest rate subsidy of 4.3 percentage points on loans, so that $\tau^c = 0.2343$. We then calibrate ζ so 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 en-

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

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

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 percent 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

trepreneurial ability distribution, ϵ; subjective discount factor, β; altruism utility factor, γ; and the strength of financial contract enforcement, ϕ. These five parameters are chosen so that in the stationary equilibrium we match the following statistics of the Brazilian economy: the capital to output ratio, which is 2.2;[24] the percent of entrepreneurs over the total labor force;[25] the Gini index of entrepreneurial earnings is 49.5%;[26] about 30 percent of aggregate capital is employed in the corporate sector;[27] and total debt to production is about 33 percent of income. Table 4 reports the key statistics for the Brazilian and our model economy.

3.2.2 Quantitative Experiments

Credit Subsidies:

Now we conduct counter-factual exercises. We vary the level of credit subsidies and evaluate the quantitative implications on output per capita, wages, wealth inequality, fraction of subsidized loans, payroll tax rate and government finances. Figure 4 reports the results for an economy with an endogenous and exogenous in-

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[24]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 0.9039. Since the model period is 5 years, this implies that agents discount the future at a rate of about 2% per year.

[25]Using microdata from the 2008 Brazilian households survey (PNAD), we find that the percent of people in the labor force who employ at least one worker is about 2%. Self-employment 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 Brazil's strict labor laws and regulations. We define entrepreneurs as those who manage a labor force with income higher than the minimum wage (R$415 in 2008), then the percent of entrepreneurs in the labor force is about 7.6%.

[26]This can be found using the 2008 PNAD.

[27]We define the corporate sector as all firms listed in the Brazilian stock market. BMF & BOVESPA data, available at http://www.bmfbovespa.com.br/, indicate that total permanent assets of listed firms in Brazil are 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.

terest rate. The effects, as in the United States case, are roughly the same whether the interest rate is exogenous or endogenous.
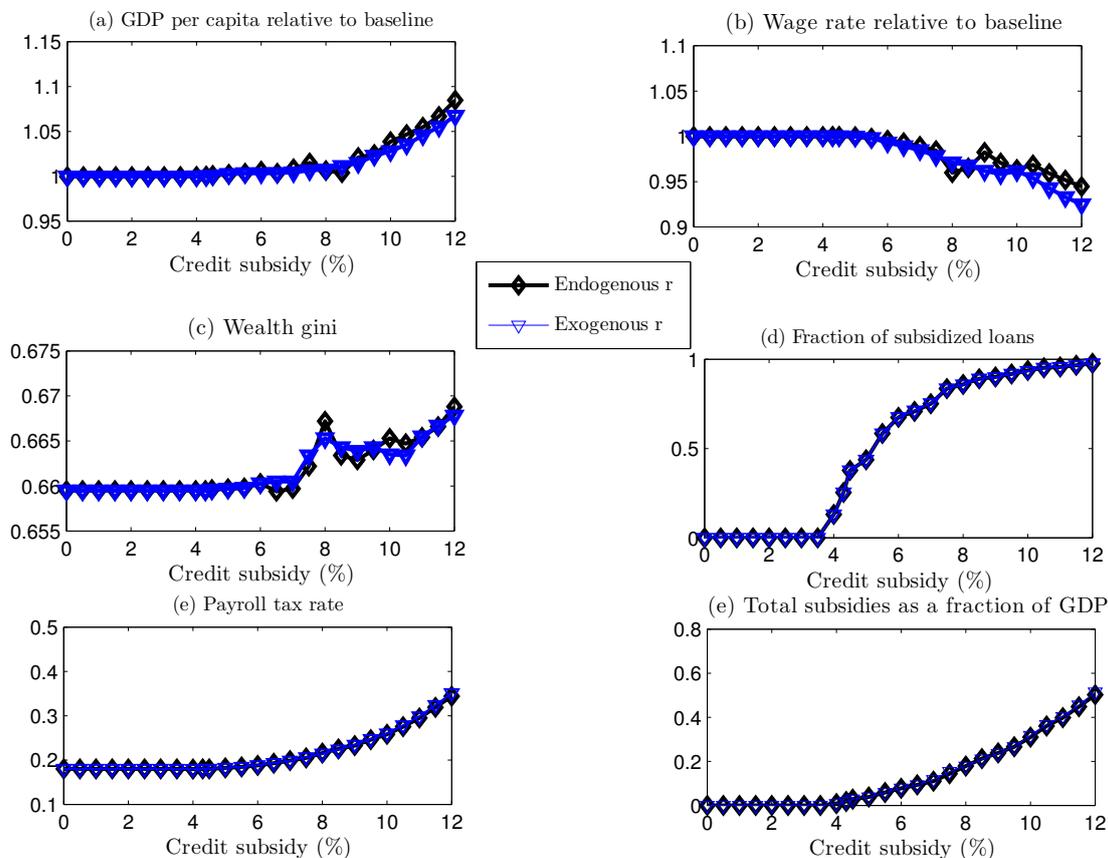
Figure 4: Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) Fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP.

When we cut interest rate subsidies from the 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 subsidized, there is no quantitative impact on the economy. If, however, we increase the level of interest rate subsidy, then we observe some quantitative impact on the variables. Output per capita increases monotonically, but wages decrease. For instance, if interest credit subsidies increase from 4.3 percentage points to 10 percentage points,[28] 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.[29] The

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[28]This is 61 percentage points in 5 years.

[29]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.

program is expensive: total credit increases from 30 percent to 55 percent of income and subsidized credit goes from 7.5 percent to 52 percent of income, while the total program cost goes from 1.76 to 31 percent of income.

Consider now additional exercises. We first keep τ^c at its baseline value of 4.3 percent and decrease the fixed cost so that the fraction of subsidized loans increases in the economy. This policy expands the subsidized credit program and increase its efficiency. Note, however, that the payroll tax rate must adjust to compensate for lost revenue from 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 does the share of the corporate sector. Total credit as a fraction of output increases by 2 percentage points. In experiments 2 and 3 in Table 5(a), we decrease further fixed cost ζ so that the share of subsidized credit in the economy is about 70 and 90 percent of total credit, respectively. 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 that decreases entry barriers might lead to a slight increase in output and wages, and therefore efficiency (high ability but low wealth agents are funded as program access increases).

The experiments so far assumed that financial intermediaries could charge the same spread, η, on subsidized loans. However, most BNDES credit lines have a 4% cap on the spread that financial institutions can charge, determined by the *FGPC* (*Fundo de Garantia para a Promoção da Competitividade*). See BNDES (2010).[30] Given this, the cost of a BNDES loan is: (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 credit is direct without financial intermediaries. About 50 percent of all credit operations are made through financial intermediaries. The final cost of BNDES loans in general is thus about 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 in the previous calibration and τ^c is about 12 percent per year.

The cap on the interest rate spread that financial intermediaries can charge on subsidized loans implies in the model that they must charge a higher rate on non-subsidized loans to compensate for any loss on subsidized loans. In this case,

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

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).[31] Souza-Sobrinho (2010) reports that the level of subsidized loans affects the total spread. In the baseline economy, the total spread on non-subsidized loans is 13.08 percent per year,[32] while subsidized loans have no spread relative to the deposit rate.

Table 5(b) reports the results of experiments that recalibrate model parameters to match the same targets as in Table 3, except policy parameter τ^c is now 12 percent instead of 4.3 percent per year.[33] We then do the following counter-factual exercises. First, experiment 1 in Table 5(b) cuts all credit subsidies in the economy. As in Figure 4 there is no significant quantitative effect on per capita income, the wage rate or the labor tax rate.[34] 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.

Experiment 2 in Table 5(b) keeps τ^c at its baseline value (12 percent) and decrease the fixed cost in such a way 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, then output, wages and inequality remain roughly the same. Total credit as a fraction of output falls by 2 percentage points,[35] and the share of the corporate sector increases from 30 to 35 percent. Experiment 3 in table 5(b) further decreases fixed cost ζ so that the share of subsidized credit in the economy is about 70 percent of total credit. 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. The 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 relative to the baseline deposit rate. Finally, experiment 4 in table 5(b) decreases ζ so 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. The payroll tax rate must increase by 7 percentage points

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[31]This is multiplied by 0.50 since about 50% BNDES loans are made through intermediaries.

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

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

[34]The fixed cost is high enough to finance the program.

[35]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 credit subsidy effect; endogenous interest rate.

|	Y% base	w% base	Ent Y %	K/Y	Gini ent%	Gini wealth%	Cred Y%	subs %	size corp	cost %Y
Part (a) Brazil: Fix τ^c and lower cost ζ										
Baseline:	100	100	7.54	2.13	49.0	66	29.4	25.4	30	1.76
ζ_b	$\tau^w = 18\%$	$\tau^c = 4.3\%$								
Exp. 1:	100.63	100.31	7.53	2.13	49	66	31	50	30	3.5
$0.75\zeta_b$	$\tau^w = 18.27\%$	$\tau^c = 4.3\%$								
Exp. 2:	100.74	100.41	7.52	2.13	49	66	32	70	30	5.1
$0.56\zeta_b$	$\tau^w = 18.68\%$	$\tau^c = 4.3\%$								
Exp. 3:	101.9	100.06	7.51	2.08	50.1	66	37	90	25	7.8
$0.20\zeta_b,$	$\tau^w = 20.18\%$	$\tau^c = 4.3\%$								
Part (b) Brazil: Increase τ^c from 0 to 12% and lower cost ζ										
Baseline:	100	100	7.79	2.11	48.9	66.2	27	26	30	5.26
ζ_b	$\tau^w = 18\%$,	$\tau^c = 12\%$								
Exp. 1:	100.17	100.09	7.80	2.00	48.95	66.3	30	0	22.4	0
ζ_b	$\tau^w = 18\%$	$\tau^c = 0$								
Exp. 2:	100.71	99.71	7.79	2.24	49	66.1	25	50	35	9.10
$0.75\zeta_b$	$\tau^w = 18.59\%$	$\tau^c = 12\%$								
Exp. 3:	100.01	98.76	7.79	2.25	49.3	66	24	70	37	12
$0.56\zeta_b$	$\tau^w = 19.33\%$	$\tau^c = 12\%$								
Exp. 4:	102.7	97.64	7.73	2.53	51	66	32	90	43	22
$0.20\zeta_b$	$\tau^w = 25\%$	$\tau^c = 12\%$								

relative 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 relative to the baseline.

Investor protection:

For comparison, we now run the following alternative policy experiment. We keep all the parameters the same as in the Brazilian baseline economy, reported in Table 3, but we now change the value of the enforcement parameter $\phi \in [0, 1]$.[36] As discussed previously, ϕ corresponds to a penalty which entrepreneurs face when they do not honor their promises to repay their debt and it reflects the strength of contract enforcement in the economy. A smaller ϕ corresponds to a low level of enforcement of financial contracts, while when ϕ goes to one it implies an increase in the level of contract enforcement. This is similar to the exercises implemented by Antunes, Cavalcanti, and Villamil (2008b), among others.

Figure 5 reports the effects of variations on the enforcement parameter on four statistics: GDP per capita relative to the baseline; wage rate relative to the base-

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[36]The level of subsidized credit varies endogenously and the payroll tax rate is adjusted to balance the government budget constraint.
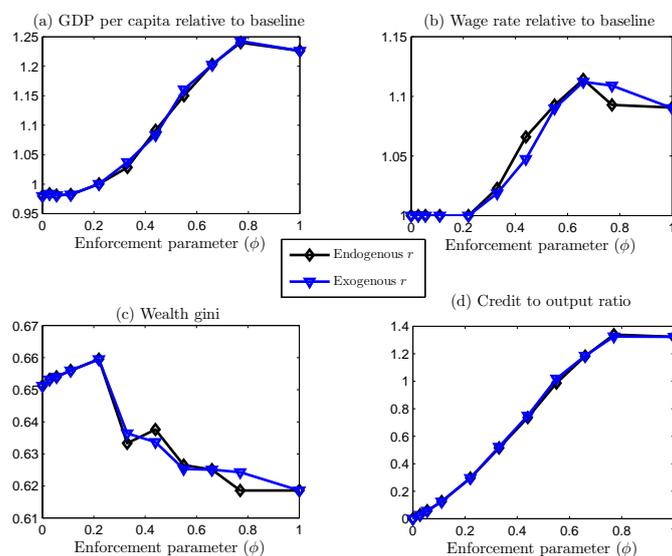
Figure 5: Long run effects of financial reforms that change the level of investor protection: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) credit to output ratio.

line; wealth Gini coefficient; and the credit to output ratio. This figure shows the following: if the level of contract enforcement increases by a factor of 2, then output per capita would increase by 10 percent, the wage rate would increase by 6 percent, wealth inequality would decrease, and the credit to output ratio would increase by a factor of 4.

In order to investigate how ϕ varies across countries, we use an independent measure of ϕ based on the legal rights index which indicates the degree to which collateral and bankruptcy laws facilitate lending. This index follows previous work by La Porta, Lopes-de-Silanes, Shleifer, and Vishny (1998), and includes seven aspects of collateral law and three aspects of bankruptcy law and it is reported in the website 'Doing Business' of the World Bank. The index ranges from 0 to 10, with

higher scores indicating that collateral and bankruptcy laws are better designed to promote access to credit.

To determine the parameter estimate for ϕ, multiply the ratio of the country's legal rights index to the Brazilian value by the baseline $\phi = 0.22$. We implicitly assume that the relationship between the index and the parameter is linear, at least locally.[37] This procedure could produce values beyond the support of the parameter, but this is unlikely given our relatively low calibrated baseline value. For Korea, the corresponding value is $\phi = 2.33 \times 0.22 = 0.51$.[38] Therefore, if Brazil increased its level of contract enforcement to the level observed in Korea, keeping all other parameters the same, then output per capita and wages would increase by 13 and 8 percent, respectively. Inequality in wealth would decrease. These experiments suggest that, for realistic changes in the legal protection of contracts, considerable gains in output and wages could occur. These changes are much larger than changes from credit subsidies.

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 have no significant effect on output per capita, but can have important negative effects on wages and government finances. The subsidies are a transfer from workers to a small number of entrepreneurs.

For Brazil, a country in which financial repression is high and the government subsidizes heavily loans provided by its main development bank (BNDES), our counter-factual exercises show that if all interest subsidies were cut, there would be no significant quantitative effect on output per capita, wages, inequality or government finances. This suggests that loan subsidies have not been effective in remedying capital and other misallocation problems that arise from Brazil's strong financial frictions. However, we also show that increased interest rate subsidies increase output per capita, while decreasing wages by almost the same percentage. Interestingly, when we keep interest rate subsidies at the level observed in Brazil but increase access to the credit program by decreasing the entry barrier to participate in the program, then output and wages might both increase as long as the payroll tax rate

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[37]This is an approximation, and we know that the polar cases coincide.

[38]Notice that this corresponds to the written law. If we also consider the rule of law then the difference between Brazil and Korea would be even larger. Therefore, we can see this as a lower bound of the difference in investor protection between the two countries.

effect is not too large and interest rate subsidies do not affect directly the spread on non-subsidized loans.

Our quantitative exercises for both the United States and Brazil, consistent with empirical evidence, suggest that providing interest rate subsidies is not an effective way to reduce the underinvestment problem that can result from capital frictions. The program does not significantly increase output, but reduces wages. Thus, countries should focus on financial reforms that improve the functioning of financial and credit markets directly, such as reforms that increase creditor protection, and decrease asymmetric information and intermediation costs. In developing countries with a high level of financial repression, such reforms might have a sizeable impact on development, while, in general, credit subsidies function as a transfer from workers to a small group of entrepreneurs. Such programs seem better explained by political, rather than economic considerations.

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A Additional tables

Table 6: Policy Experiments: Long run credit subsidy effect; endogenous interest rate

	Y% base,	w%, base	Ent %	K/Y	Ent Y Gini	Wealth Gini	r% year	Cost %Y	Subsidy %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 (b): 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 (e): 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 credit subsidy effect; exogenous interest rate

	Y% base,	w%, base	Ent %	K/Y	Ent Y Gini	Wealth Gini	r% year	Cost %Y	Subsidy %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 (b): 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 (e): 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