The Effects of Credit Subsidies on Development*

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September 17, 2012

Abstract

Under credit market imperfections, the marginal productivity of capital will not necessarily be equalized, resulting in misallocation and lower output. Preferential interest rate policies were and are tools used by many governments intended to increase investment and output. This paper constructs a general equilibrium model of economic growth and development with heterogeneous agents to quantitatively evaluate the aggregate effects of such policy. 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 U.S., this interest credit subsidy does not have a significant effect on output, but it can have negative effects on wages and government finances. Counterfactual exercises for Brazil, a developing country in which financial repression is high and loans are heavily subsidized, show that if all interest subsidies were cut, no significant quantitative effect would occur on development. The program is largely a transfer from households to a small group of entrepreneurs with minor aggregate effects.

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

JEL CLASSIFICATION: E60; G38; O11

*We thank Breno Albuquerque, Francesco Caselli, Fernando de Holanda Barbosa Filho, Giammario Impullitti, Marcelo Mello, Marcelo dos Santos, André Silva, Arilton Teixeira, and Pedro Telles for helpful comments and suggestions. We have also benefited from comments by audiences at the EPGE/CAEN Meeting, LuBraMacro meeting, REAP Meeting, SAET Meeting, INSPER-SP, PIMES/UFPE, PUC-RJ, Thema-Cergy, University of Cambridge, University of Illinois, and Workshop on Advances in Economic Growth at University of St Andrews. We also thank financial support from INOVA-FCT and CNPq.

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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. Therefore, perfect credit markets equalize 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 misallocation and lower equilibrium output.

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-

[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, what are the economic effects of credit subsidies? We therefore 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. The equilibrium of the model is constrained efficient. There are some misallocation in equilibrium, since some entrepreneurs are credit constrained and therefore have a marginal productivity large than the equilibrium interest rate, but there is no market mechanism which would transfer capital from an entrepreneur with a marginal productivity equal to the interest rate to a credit constrained entrepreneur. We introduce a credit program, which subsidizes the interest rate on loans, in this framework. There is a fixed cost (which might be null) to apply for subsidized loans, in the form of bureaucracy and regulation compliance. The credit program is financed by a payroll tax and we also investigate the case in which it is financed by a lump-sum 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

[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.

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. Clearly some entrepreneurs who are credit constrained and therefore have a marginal productivity of capital larger than the interest rate will benefit from the program. However, the access to this subsidy is open to all entrepreneurs who pay the fixed cost and therefore this program might also finance entrepreneurs whose marginal productivity of capital is equal to the non-subsidized loan rate. Therefore, it is not clear what would be the effects of these subsidies on, for instance, aggregate output. This paper provides quantitative analysis of such subsidies on development.

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 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. 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 Stutze (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 dy-

[3]The final interest rate on BNDES loans also contains a spread charged by BNDES and a financial intermediary spread. See section 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.

namic with all prices determined endogenously. Li (2002) in a general equilibrium model with entrepreneurs and occupational choice, studies a related but 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. Recently, in a model similar to ours, Buera, Kaboski, and Shin (2012) provide a quantitative evaluation of the aggregate and distributional impact of credit programs which target small businesses. They show that financial innovations which improve credit access for small entrepreneurs have limited aggregate effects.[6]

Our simulations indicate that credit subsidies do not have a strong effect on 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, then output per capita increases by less than 3 percent in the long run. However, the wage rate decreases by about 1.3 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.[7]

The equilibrium of the model is constrained efficient and interest rate credit subsidies do not seem to improve allocations.[8] Therefore, the exercise for the U.S., in

[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.

[6]Notice that our policy is different from theirs. We consider interest subsidies, while they consider the introduction of financial innovations which improve credit access to small entrepreneurs. Buera, Moll, and Shin (2012) also investigate the effects of credit subsidies but in their paper the government targets initially more talented entrepreneurs. But since entrepreneurial talent changes over time, such policy creates long run misallocations. In our model, selection in subsidized loans are endogenous and any entrepreneur who pays the entry cost have access to cheap loans.

[7]We also consider the case in which the government finances interest rate credit subsidies by levying a lump-sum tax on households. In this case, both output and wages increase, but the net wage (wage rate minus the lump-sum tax) decreases.

[8]Since there is no equalization of the marginal productivity of capital in equilibrium, the only

which we vary the level of the interest rate credit subsidies, is a valid exercise to evaluate quantitatively how bad are these policies for development. We then implement pure counterfactual exercises. We use independent estimates of intermediation costs, contract enforcement and subsidy policy for Brazil, and keep the other parameters at the U.S. level. Implicitly, we assume that the U.S. economy is the equilibrium constrained efficient one and investigate how Brazilian financial market polices and institutions affect such equilibrium.[9] This gives an estimate of how much of the difference in output per capita between Brazil and the U.S. can be accounted for by differences in financial market institutions and credit market policies.[10] Brazil is particularly interesting because financial repression is high and the government subsidizes heavily loans provided by its main development bank (BNDES). The results show that credit subsidies have a small aggregate effect on output and wages. On the other hand, enforcement of financial contracts and intermediation costs can explain about 25 percent of the difference in output per capita between Brazil and the U.S. Therefore, interest rate subsidies is not an effective way to reduce the underinvestment problem that can result from capital market frictions. Developing countries should focus on financial reforms that improve the functioning of financial and credit markets directly. Such reforms might have sizeable impacts on development, while, in general, credit subsidies function as transfers from households to a small measure of entrepreneurs.

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.[11] While our results are consistent

way to improve allocations is to transfer income from entrepreneurs with a relative low marginal productivity of capital to entrepreneurs with a high marginal productivity of capital. Then, they would share the gains of such trade. However, there is no market mechanism to implement such a policy, which has to be incentive compatible.

[9] In another words, our exercises investigate the size of the inefficiency generated by Brazilian financial market institutions and policies.

[10] According to the Heston, Summers, and Aten (2012), American output per capita is 5 times larger than Brazil's output per capita.

[11] 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 develop-

with these econometric analyzes, 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.

ment bank as a shareholder alleviates capital constraints faced by publicly traded companies.

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.

2.1.2 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:

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

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

$$(1 + \tau^w)w = (1 - \theta)B(K^c)^\theta (N^c)^{-\theta}, \tag{2}$$

$$r + \delta = \theta B(K^c)^{\theta-1}(N^c)^{1-\theta}. \tag{3}$$

Noncorporate sector

Managers operate a technology that uses labor, n, and capital, k, to produce a

single consumption good, y, that is represented by

$$y = f(x; k, n) = x^{\nu}(k^{\alpha}n^{1-\alpha})^{1-\nu} + (1-\delta)k, \quad \alpha,\ \nu, \delta \in (0,1). \tag{4}$$

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.

2.1.3 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.

2.1.4 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.[12] 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 $r_B = r + \eta$.[13]

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.

[12] See Antunes, Cavalcanti, and Villamil (2012) for a model in which η arises endogenously due to an explicit financial intermediation technology that depends on capital and labor.

[13] 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.

2.1.5 Government

A government raises revenue through a payroll labor tax, τ^w, to finance exogenously given government spending, g, and to subsidize credit,[14] 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.[15] 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. This fixed cost ζ is reminiscent of the fixed cost for financial market participation in Greenwood and Jovanovic (1990) and Acemoglu and Zilibotti (1997).

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.[16] 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.

2.1.6 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

[14] 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 in the numerical exercises. As a consequence, our results will provide a lower bound on the distortionary effects of this credit policy. We also provide exercise in which the program is financed through a lump-sum tax.

[15] 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.

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

problem of a household can be written as:

$$\max_{a^{j'}, c^j, b_{J+1}} \sum_{j=1}^{J-1} \beta^{j-1} \frac{(c^j)^{1-\sigma} - 1}{1-\sigma} + \beta^{J-1} \frac{[(c^J)^{1-\gamma}(b_{J+1})^{\gamma}]^{1-\sigma} - 1}{1-\sigma}, \tag{5}$$

subject to

$$c^j + a^{j'} \leq W(x, a^j; w, r) + (1+r)a^j + tr, \tag{6}$$

$$W(x, a^j; w, r) = \max\{w, \max\{V^{ns}(x, a^j; w, r), V^s(x, a^j; w, r)\}\}, \tag{7}$$

$$c^j, a^{j'}, b^{J+1} \geq 0, \; j = 1, ...J, \text{ and } a^{J'} = b^{J+1}, \; a^1 = b. \tag{8}$$

Equation (6) is the household's budget constraint, with income $W(x, a^j; w, r)$ and transfers tr. Equation (7) implies that households choose an occupation to maximize income. Condition (8) states choice variable constraints and initial conditions.

2.1.7 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:

$$\pi(k, x; w) = \max_n f(x; k, n) - (1 + \tau^w)wn. \tag{9}$$

Equation (9) yields the labor demand of each entrepreneur, $n(k, x; w)$. Substituting $n(k, x; w)$ into (9) 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

$$V^h(a^j, x; w, r) = \max_{d \geq 0, \; l \geq 0} \pi(d + l, x; w) - (1+r)d - (1 + r + \eta - \tau^c \mathbf{1}_s)l - \mathbf{1}_s \zeta, \tag{10}$$

$$h = ns, s,$$

subject to the credit market incentive constraint and feasibility

$$\phi \pi(d + l, x; w) \geq (1 + r + \eta - \tau^c \mathbf{1}_s)l, \tag{11}$$

$$a^j \geq d. \tag{12}$$

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 (11) 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 (12) 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.

2.1.8 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

$$E(w, r) = \{(a^j, x) \in \Omega : \max\{V^{ns}(x, a^j; w, r), V^s(x, a^j; w, r)\} \geq w\}. \tag{13}$$

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

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

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

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

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 (11) 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 (11) 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.

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 (11) 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

Figure 1: Occupational choice.

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

$$\Upsilon' = \sum_{j=1}^{J} \int P(a^j, A)\Upsilon(da^j). \tag{16}$$

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:

$$\sum_{j=1}^{J} \iint_{z \in E(w,r)} n(x, a^j; w, r)\Upsilon(da^j)\Gamma(dx) + N^c = \sum_{j=1}^{J} \iint_{z \in E^c(w,r)} \Upsilon(da^j)\Gamma(dx), \qquad (17)$$

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

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

$$\sum_{j=1}^{J} [\iint_{z \in E(w,r)} \tau^w w n(x, a^j; w, r)\Upsilon(da^j)\Gamma(dx) + \iint_{z \in E^s(w,r)} \zeta \Upsilon(da^j)\Gamma(dx)] = \qquad (19)$$

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

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[17] and for the sake of space we only report the simulations in which equation (19) is satisfied. Finally, assume that intermediation cost, η, is redistributed back to households:

$$\sum_{j=1}^{J} \iint tr \Upsilon(da^j)\Gamma(dx) = \sum_{j=1}^{J} \iint_{z \in E(w,r)} \eta l(a^j, x; w, r)\Upsilon(da^j)\Gamma(dx). \qquad (20)$$

In a similar model, 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.

[17]It is also similar when ζ is pure deadweight loss.

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.[18] As a result, each agent has a productive lifetime of 45 years. Assume that the cumulative distribution of managerial ability is given by $\Gamma(x) = x^{\frac{1}{\epsilon}}$ and $x \in [0, 1]$. 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 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.[19] 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 the average from 1999 to 2008 of banks' non-interest expenses (overhead costs) over assets is about 3.365%. Bech and Rice (2009) also report that the average value

[18]Results are not quantitatively very different when we consider the model with $J = 1$ as in Galor and Zeira (1993), and when parameters are calibrated to match the same statistics used in the baseline.

[19]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	0.2124	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	0.9225	Capital to output ratio equal to 2.55, Penn World Tables 6.2
B	0.5206	60% of aggregate capital is employed in the corporate sector (see Quadrini, 2000)

for taxes over total assets paid by banks during the same period was 0.562%, which implies that the total level of intermediation costs is 3.927% per year. 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;[20] 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).

[20]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 (2012) Penn World Tables 7.1 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 0.9225. Since the model period is 5 years, this implies that agents discount the future at a rate of about 1.63% 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	7.50
Entrepreneurs' income Gini (%)	45	45
Share of capital in the corporate sector (%)	60	60
Capital to output ratio	2.55	2.56
Ratio of bequests to labor earnings (%)	4.5	4.47
Intermediated capital to output ratio	1.8	1.87
Wealth Gini (%)	78	39.42

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 1.87. The measure of intermediated capital in the entrepreneurial sector is about 33% of output. Finally, the model does not match the wealth Gini well: the model predicts roughly 40%, 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.[21]

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'

[21] 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 80% of the baseline wage (blue solid line with a triangle marker) - the case in which subsidized loans are selected endogenously. Results for an intermediate value of ζ are displayed in the grey dotted line. 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 3% in the long run;[22] the wage rate decreases by about 1.3%; 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 0.38 to balance the government budget constraint, since government spending increases by about 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.[23]

[22]When $\zeta = 0$ the largest effect is at $\tau^c = 3.927\%$ per year: output per capita increases by 2.55%.

[23]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 7.5% to 7.93% when credit subsidy τ^c changes from 0 to 3.927% per year. See panel (a) in

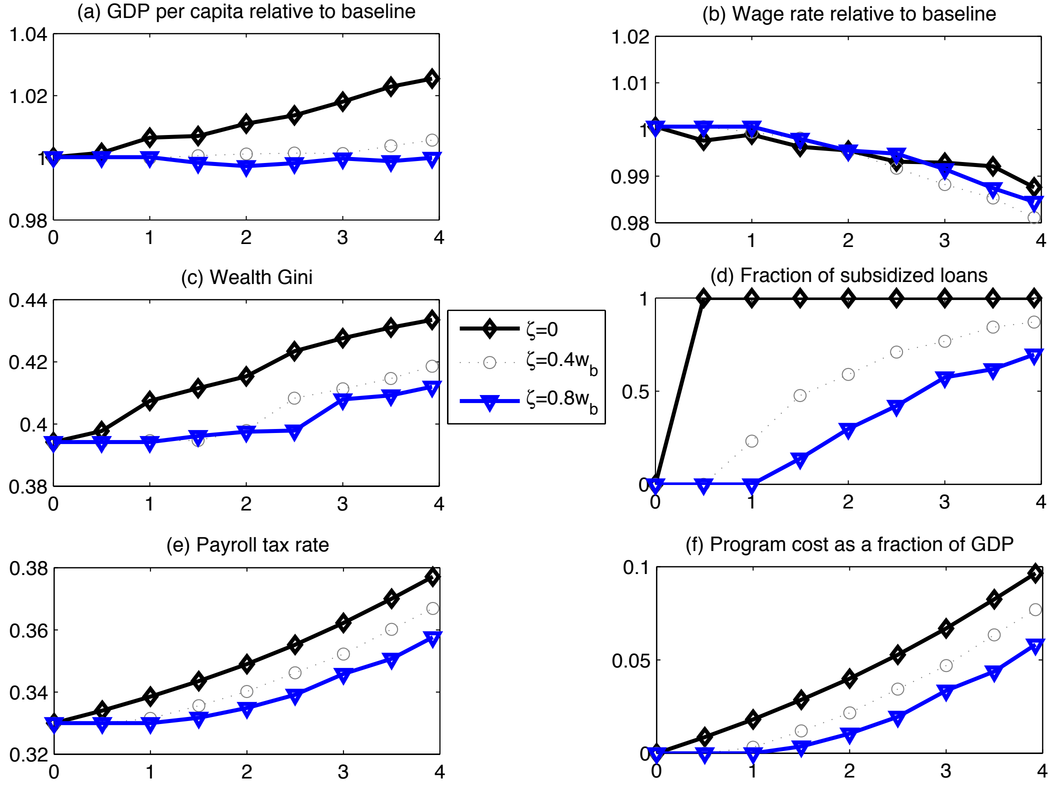

Figure 2: Economy with endogenous interest rate and distortionary labor tax. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized loans over GDP. Different lines correspond to economies with different levels of the fixed cost, ζ.

Figure 2 displays the long-run effects of credit subsidies. In order to investigate whether or not there is overshooting in the short-run in investment and output, such that long-run analysis underestimates the effects of credit subsidies on development, we calculate the transition from the baseline model to a model with positive credit subsidies. Figure 3 reports the transition of output, the wage rate, wealth Gini, and the program cost as a share of income from the baseline model with no credit subsidies to a model in which there is no fixed cost to apply for subsidized loans and there is no spread between deposit and loan rates (i.e., $\tau^c = 3.927\%$ and $\zeta = 0$).[24] Notice that output monotonically increases from the initial equilibrium to its final long-run level, while the wage rate monotonically decreases. There are no overshooting in output and the wage rate and therefore long-run analysis does not underestimate the effects of credit subsidies on development. We then focus only on

table 4 in appendix A.

[24]Transition for other experiments reported in Figure 2 follows a similar qualitative path. For the sake of space we do not report them, but they are available upon request.

the long-run analysis.

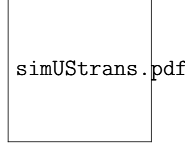

Figure 3: Economy with endogenous interest rate and distortionary labor tax. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized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

General equilibrium effect might offset the demand effect of credit subsidies. In order to understand the role of general equilibrium price changes in driving results, 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; 4.21% 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 analyzes of financial reforms that improve creditors' rights. 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 deposit rates are the same for different levels of the fixed cost (see also table 5 in appendix A).

Figure 4 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 smaller 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 null. In this case, output increases by 2.16% relative to the baseline. Notice, however, that the negative effects on government finances are still strong. The wage rate decreases by 3.5%. Overall there is no major quantitative difference and the interest rate does not change much, see Table 4 in Appendix A.[25]

We also study the role of the payroll tax in shaping results. In our baseline model the program is financed through a payroll tax (τ^w). We now consider a

[25]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.

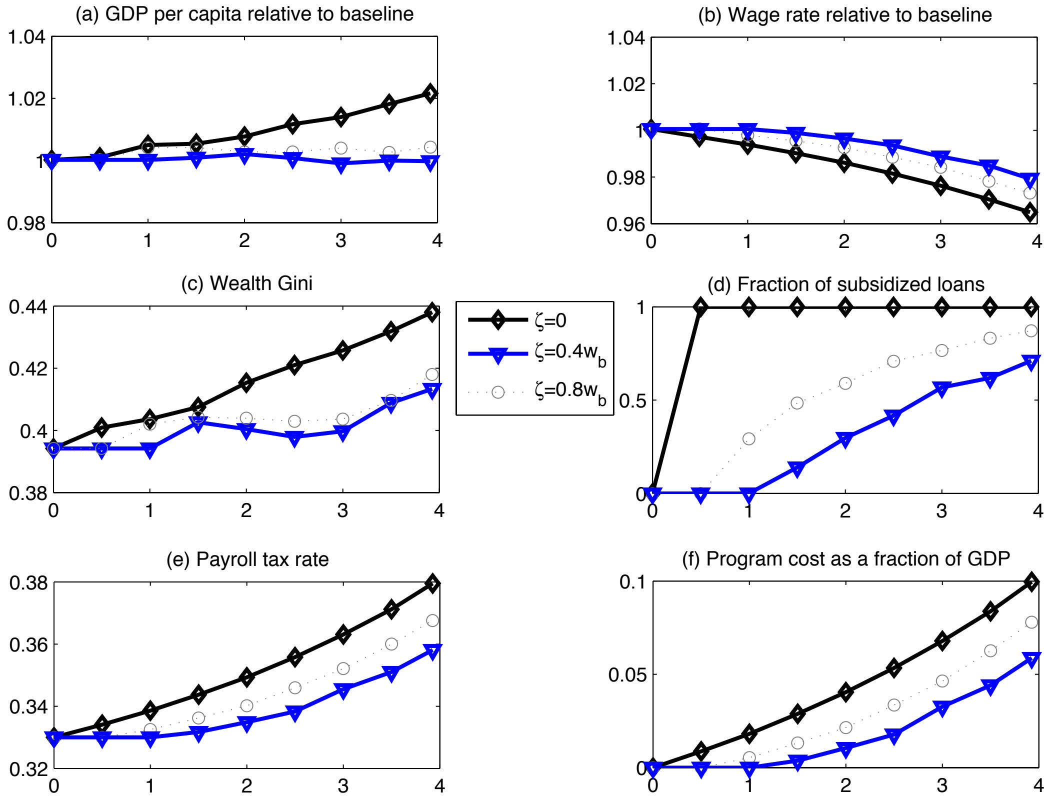

Figure 4: Economy with exogenous interest rate and distortionary labor tax. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) Fraction of subsidized loans; (e) payroll tax rate; and (f) total subsidized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

model similar to the one presented in Section 2, but we assume that the program is financed through a lump-sum tax on all households. Results are presented in Figure 5. See also Table 6 in Appendix A. We can observe that in this case both the output per capita and the wage rate increase in the long-run. In the experiment with no fixed costs, output per capita and the wage rate increase by 2.38% and 2.26%, respectively, when credit subsidy, τ^c, changes from 0 to 3.927% per year. Notice, however, that total subsidies as a fraction of income still increases by roughly 10 percentage points, which implies a transfer of resources from households to a small fraction of entrepreneurs.[26] The net wage income, which corresponds to the wage rate minus the lump-sum tax, decreases by roughly 4% relative to the baseline.

[26]The share of entrepreneurs in the labor force increases from 7.5% to 7.79%.

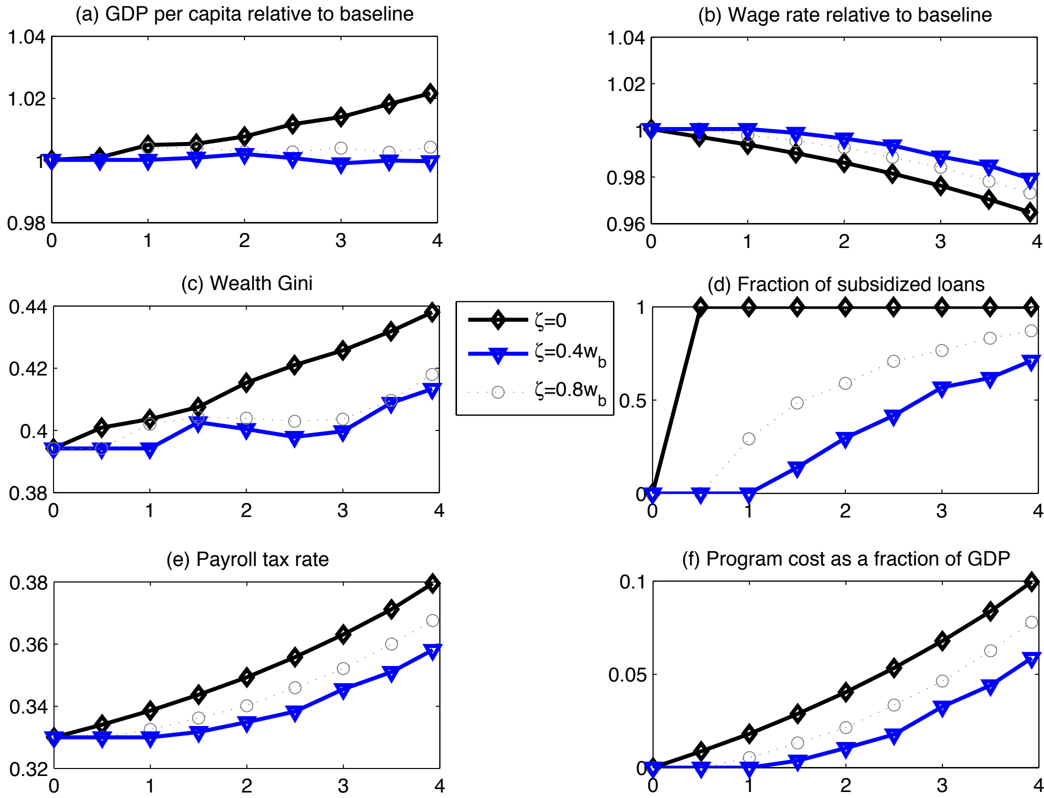

Figure 5: Economy with endogenous interest rate and lump-sum tax. Long run effects of credit subsidies on: (a) GDP per capita relative to the baseline; (b) wage rate relative to the baseline; (c) wealth Gini index; (d) fraction of subsidized loans; (e) Net wage relative to baseline; and (f) total subsidized loans over GDP. Different lines correspond to economies with different levels of the fixed cost, ζ.

3.1.3 Counterfactual Analysis: Brazil

The previous experiments describe quantitative properties of the model for systematic variations in the level of credit subsidies, τ^c, and on the entry barrier for such subsidies, ζ. We now use independent estimates of intermediation costs, contract enforcement and subsidy policy for Brazil, keeping the other parameters at the U.S. level. The purpose of this counterfactual exercise is to investigate what the level of U.S. output per worker would be if financial contract enforcement, intermediation costs, and interest subsidy policy were the same as in Brazil.[27] This gives an estimate of how much of the difference in output per worker between Brazil and the U.S. can be accounted for by differences in financial market imperfections and credit market policies. There are two reasons why we do this exercise. One is empirical.

[27]We do not assume that other parameters in Brazil are the same as those observed in the U.S. The goal is to isolate the effects of intermediation costs, enforcement, and credit subsidies. This is a pure counterfactual exercise.

Financial repression is high in Brazil and the government subsidizes heavily loans provided by its main development bank (BNDES). The second reason is because the model is constrained efficient. Then, we assume that the U.S. economy is the constrained efficient one and investigate the Brazilian financial market polices and institutions affect such equilibrium.[28]

Beck, Demirgüç-Kunt, and Levine (2009) report that the ratio of banks' overhead costs to total assets is about 11% in Brazil. In addition, Demirgüç-Kunt and Huizinga (1999) show that the value for taxes over total assets paid by banks is roughly 1%. Therefore, we set η such that the annual value of intermediation costs is 12%.[29] As in Antunes, Cavalcanti, and Villamil (2008b), two methods are used to assess enforcement parameter ϕ: a *de juris* measure based on the written law and a *de facto* measure to account for how laws are likely to be enforced. For the *de juris* measure we use a legal rights index which indicates the degree to which collateral and bankruptcy laws facilitate lending. 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 legal rights index of Brazil (3) to the U.S. value (9) by the baseline $\phi = 0.225$.[30] The corresponding value for Brazil is $\phi = \frac{3}{9} \times 0.225 = 0.075$. The written law is only part of investors' legal protection. Another part is the overall quality of the rule of law in the country, as this determines how the written law is enforced in practice. We also define investor protection by the previous legal rights index times a rule of law indicator. The rule of law index computed by Kaufmann, Kraay, and Mastruzzi (2003), measures the degree to which laws are enforced in society.[31] According to this index, the U.S. has a score of 8.16 while Brazil has a score of 2.50. Investor protection between the U.S. and Brazil now varies by a factor of 10, while with *de juris* measure the difference of investor protection in the two countries is a factor of 3.

We now set the value for policy parameter τ^c and institutional parameter ζ. The

[28]In an accompanying technical note, available at *http://sites.google.com/site/tiagovcavalcanti/research-1*, we also calibrate all parameters so that the long run equilibrium matches statistics of the Brazilian economy and perform exercises within the Brazilian economy. We consider different cases, including when there is a cap on the interest rate that financial intermediaries can charge in subsidized loans. he effects of credit subsidies on development seem to be robust to different calibrations of the model and are consistent to the findings reported here.

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

[30]We implicitly assume that the relationship between the index and the parameter is linear, at least locally. This is an approximation, and we know that the polar cases coincide.

[31]We use the 2010 rule of law index, which varies from -2.5 to 2.5, normalized to a 0 to 10 interval. Higher scores indicate that agents have higher confidence in the rules of society.

Brazilian National Development Bank (BNDES) is the main supplier of subsidized credit and it also provides funding for regional development banks in Brazil. 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%, while the government lent to BNDES at about 6%. BNDES has no branches and it provides credit mostly through commercial and regional development banks,[32] 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.[33] Therefore, we assume that BNDES provides an annualized interest rate subsidy of 4.3 percentage points on loans, so that $\tau^c = 0.2343$. According to Sant'Anna, Borça-Junior, and de Araujo (2009), BNDES is responsible for about 18% of all credit in Brazil. The World Development Indicators reports that private credit over output in Brazil has been growing recently and in 2008 it reached about 45% of GDP. However, not all loans go to firms. Sant'Anna, Borça-Junior, and de Araujo (2009) report that about 35% of the total credit in Brazil finances either family consumption or housing. Therefore, credit to production is about 29% of income and BNDES loans account for about 27% of all productive credit.[34] We thus calibrate ζ so that the share of subsidized credit is about 27 percent of all credit in our model economy.

We also have to adjust the TFP parameter of the production function in the corporate sector, such that the share of capital in the corporate sector is similar to the one in the Brazilian economy. Otherwise, with the financial repression observed in Brazil (values for ϕ and η), the size of the corporate sector will be too large relative to the one observed in the Brazilian economy. We define the corporate sector as all firms listed in the Brazilian stock market. BMF & BOVESPA data[35] 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,[36] this implies that about 30% of the capital is

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

[33] 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.

[34] It is important to highlight that BNDES also finances the corporate sector (see Torres-Filho, 2009) in which the marginal productivity of capital is lower than for some credit constrained entrepreneurs. In our model, all credit subsidies go to entrepreneurs and therefore we should see our results as an upper bound of the effects of credit subsidies in Brazil on output.

[35] Available at http://www.bmfbovespa.com.br/

[36] Using the Heston, Summers, and Aten (2012) Penn World Tables 7.1 and the inventory method, we find a value of 2.2 for the Brazilian economy.

employed in the corporate sector in Brazil. Therefore, we adjust the TFP parameter B such that the capital share of the corporate sector is equal to 30%.

Table 3: Empirical Data and Model Predictions for Brazil.

	Parameters					Variables			
	ϕ	η % per year	τ^c % per year	ζ % of w_b	B	GDP per capita (y)	Wage rate (w)	Frac. of subs. loans (%)	Share of corp. sector (%)
Baseline case	**0.225**	**3.927**	**0**	**0**	**0.52**	**100**	**100**	**0**	**60**
Part (a): *De juris* ϕ									
Counterfactual Brazil (data)	**0.075**	**12**	**4.3**	**65**	**0.38**	**79** (20)	**78** (30)	**27**	**30**
Model's predictions									
1) Intermed. costs	0.075	3.927	4.3	65	0.38	82	81	55	21
2) Enforcement	0.225	12	4.3	65	0.38	85	82	79	3
3) Intermed. costs & enforc.	0.225	3.927	4.3	65	0.38	95	89	90	0
4) Credit subsidies	0.075	12	0	65	0.38	80	79	0	31
5) Intermed. costs & enforc. & credit subsidies	0.225	3.927	0	65	0.38	93	92	0	0
6) TFP in corpor sector	0.075	12	4.3	65	0.52	95	96	1	76
7) TFP in corpor sector & Intermed. costs & enforc.	0.225	3.927	4.3	65	0.52	100	99	75	56
Part (b): *De facto* ϕ									
Counterfactual Brazil (data)	**0.023**	**12**	**4.3**	**20**	**0.36**	**77** (20)	**77** (30)	**30**	**30**
Model's predictions									
1) Intermed. costs	0.023	3.927	4.3	20	0.36	78	77	56	29
2) Enforcement	0.225	12	4.3	20	0.36	87	83	97	0
3) Intermed. costs & enforc.	0.225	3.927	4.3	20	0.36	97	89	99	0
4) Credit subsidies	0.023	12	0	65	0.36	77	77	0	30
5) Intermed. costs & enforc. & credit subsidies	0.225	3.927	0	20	0.36	93	92	0	0
6) TFP in corpor sector	0.023	12	4.3	30	0.52	94	95	0	77
7) TFP in corpor sector & Intermed. costs & enforc.	0.225	3.927	4.3	20	0.52	101	98	84	53

Table 3 contains the results of the counterfactual exercises. Part (a) reports exercises in which we use the *de juris* measure for ϕ, while Part (b) uses *de facto* measure for ϕ. The first row in bold displays the key parameters of the model related to the functioning of the financial market (ϕ, η, τ^c, ζ, B) of the U.S. economy along with the normalized value of output per capita and wage rate, and values for the share of capital in the corporate sector. The second row reports the value of the enforcement (ϕ), intermediation costs (η), and credit policies (τ^c and ζ) parameters observed in the Brazilian economy. It also displays the value of the TFP factor (B) in the corporate sector, which would match the share of capital if the corporate sector of Brazil's data.[37] Finally, it contains the output per capita and the wage

[37]The equilibrium real interest rate is smaller than the one observed in the United States, since

rate relative to the baseline generated by the model and the values observed in the data (in parentheses).[38] Notice that output per capita in Brazil relative to the U.S. level is roughly 20 percent, while in the model it is 79 percent with ϕ *de juris* and 77 percent with ϕ *de facto*.[39] Therefore, differences in the functioning of the financial sector and in the TFP parameter of the corporate sector explain roughly 25-29 percent of the difference in output per capita between Brazil and the U.S.

Next, we perform several counterfactual exercises to study the role of each factor explaining differences in income levels. In the fourth exercise, for instance, in which we cut interest rate subsidies from the Brazilian level of 4.3 percentage points per year to zero, output and wages are unchanged - independently if we use *de juris* or *de facto* measure for ϕ. Therefore, the credit subsidy policy in Brazil does not seem to have a positive effect on aggregate output and wages and does not explain any of the difference in output per capita between the two economies. It has a non- negligible impact on government finances, since the cost of the program in our counterfactual models is around 0.7 percent of income.

For comparison, in experiment 2, we keep all parameters the same as in the Brazilian counterfactual case, reported in the second row of Table 3, but we now change the value of the enforcement parameter ϕ to the value observed in the U.S. 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 up it implies an increase in the level of contract enforcement. For the case of ϕ *de juris*, output per capita would increase by 6 percentage points or roughly 7%, and the wage rate would increase by 4%. When we consider ϕ *de facto*, then output and the wage rate increase by 10 and 6 percentage points, respectively. Therefore, the enforcement parameter alone explains 9-12.5 percent of the difference in income per capita between the U.S. and Brazil.

When both intermediation costs and enforcement are changed to the level observed in the U.S. (experiment 3), then output per capita increases by 6 and 20 percentage points, depending on the measure of the enforcement used. The effect

the financial market is more repressed in Brazil, which decreases the demand for loans. Notice that this is a risk free interest rate.

[38]Output per capita is taken from Heston, Summers, and Aten (2012) and corresponds to the average value from 2008 to 2010 of the series "PPP Converted GDP Per Capita (Chain Series), at 2005 constant prices". For the wage rate, we use the 2010 hourly compensation costs in manufacturing provided by the US Bureau of Labor Statistics (BLS). See: http://www.bls.gov/news.release/pdf/ichcc.pdf.

[39]The wage rate in the model with the *de facto* ϕ is equal to 77 percent of the U.S. wage rate. In the data, wages in manufacturing in Brazil are about 30 of the U.S. level.

on output is stronger when we use the *de facto* measure. With the *de facto* measure for ϕ, enforcement of financial contracts and intermediation costs explain about 25 percent of the difference in output per capita between Brazil and the U.S. Observe that in experiment 3 the effect on the wage rate is not so strong as the effect on output. The reason is that when enforcement of financial contracts improves from the level of Brazil to the level of the United States, financial intermediaries make more loans and the share of subsidized loans increases. Then, the payroll tax rate has to increase, which decreases labor demand. In experiment 5, we change the level of enforcement and intermediary cost to the level observed in the U.S., but we also cut all interest subsidies. Notice that in this case output and the wage rate increase by almost the same amount.[40]

Differences in productivity in the corporate sector, enforcement of financial contracts and intermediation costs are able to explain 25 percent of the difference in output per capital between the U.S. and Brazil, and credit subsidies do not have any important effect on output. These experiments suggest that, for realistic changes in the legal protection of contracts and in intermediation costs, 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 quantitative effects of interest rate credit subsidies on output, wages, and inequality in a standard model of economic development with credit market imperfections. We calibrate the model to mimic key features of the United States economy and we show that interest rate credit subsidies have no significant quantitative effect on output per capita, but can have negative effects on wages and government finances. Such subsidies work as transfers from workers to a small group 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 counterfactual 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 repression and low creditor's protection. Consistent with empirical evidence, our re-

[40]Output increases by 14 and 16 percentage points, while the wage rate increases by 14 and 15 percentage points, depending on which measure of enforcement is used.

sults suggest that providing interest rate subsidies is not an effective way to reduce the underinvestment problem that can result from capital market frictions. The program does not significantly increase output, but reduces wages and can have negative effects on government finances. 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 4: Policy Experiments: Long run credit subsidy effect; endogenous interest rate and payroll tax rate

	Y base (%)	w base (%)	Ent %	K/Y	Share of corp., $\frac{K_c}{K}$	Wealth Gini	r% year	Cost %Y	Subsidy credit (%)
Baseline	100	100	7.5	2.56	0.60	39.42	4.21	0	0
	Part (a): No fixed cost, $\zeta = 0$								
$\tau^c = 1\%$ year $\tau^w = 33.8\%$	100.65	99.89	7.51	2.56	0.58	40.74	4.15	1.81	100
$\tau^c = 2\%$ year $\tau^w = 35\%$	101.1	99.55	7.65	2.54	0.56	41.53	4.09	4	100
$\tau^c = 3\%$ year $\tau^w = 37\%$	101.81	99.31	7.66	2.53	0.53	42.34	4.01	6.69	100
$\tau^c = 3.927\%$ year $\tau^w = 41\%$	102.29	99	7.93	2.53	0.52	43.1	3.95	8.25	100
	Part (b): Positive fixed cost, $\zeta = 0.4w_{baseline}$								
$\tau^c = 1\%$ year $\tau^w = 33.1\%$	100	100	7.5	2.57	0.60	39.46	4.21	0.32	23
$\tau^c = 2\%$ year $\tau^w = 34\%$	100.12	99.53	7.5	2.56	0.59	39.79	4.18	2.16	58.88
$\tau^c = 3\%$ year $\tau^w = 34.62\%$	100.14	98.82	7.5	2.55	0.57	41.13	4.16	3.44	76.73
$\tau^c = 3.927\%$ year $\tau^w = 36\%$	100.38	98.53	7.5	2.55	0.57	41.46	4.12	6.35	84.27
	Part (c): Positive fixed cost, $\zeta = 0.8w_{baseline}$								
$\tau^c = 1\%$ year $\tau^w = 33\%$	100	100	7.5	2.56	0.60	39.42	4.21	0	0
$\tau^c = 2\%$ year $\tau^w = 33.5\%$	99.73	99.55	7.5	2.56	0.59	39.75	4.23	1.05	29.71
$\tau^c = 3\%$ year $\tau^w = 34.6\%$	100	99	7.51	2.55	0.58	40.92	4.18	3.36	57.34
$\tau^c = 3.927\%$ year $\tau^w = 35\%$	99.89	98.74	7.5	2.55	0.57	40.92	4.18	4.38	61.76

Table 5: Policy Experiments: Long run credit subsidy effect; exogenous interest rate and payroll tax rate

	Y base (%)	w base (%)	Ent %	K/Y	Share of corp., $\frac{K_c}{K}$	Wealth Gini	r% year	Cost %Y	Subsidy credit (%)
Baseline	100	100	7.5	2.56	0.60	39.42	4.21	0	0
Part (a): No fixed cost, $\zeta = 0$									
$\tau^c = 1\%$ year $\tau^w = 33.8\%$	100.5	99.39	7.65	2.50	0.56	40.75	4.21	1.81	100
$\tau^c = 2\%$ year $\tau^w = 34.9\%$	100.77	98.61	7.66	2.48	0.54	41.53	4.21	4.04	100
$\tau^c = 3\%$ year $\tau^w = 36.3\%$	101.4	97.63	7.91	2.41	0.50	42.1	4.21	6.79	100
$\tau^c = 3.927\%$ year $\tau^w = 37.9\%$	102.16	96.49	7.94	2.34	0.46	43.8	4.21	9.96	100
Part (b): Positive fixed cost, $\zeta = 0.4w_{baseline}$									
$\tau^c = 1\%$ year $\tau^w = 33.3\%$	100.4	99.79	7.52	2.5	0.55	40.2	4.21	0.53	29
$\tau^c = 2\%$ year $\tau^w = 34\%$	100.28	99.26	7.51	2.56	0.59	40.39	4.21	2.15	58.97
$\tau^c = 3\%$ year $\tau^w = 35.2\%$	100.4	98.41	7.51	2.52	0.56	40.36	4.21	4.63	76.64
$\tau^c = 3.927\%$ year $\tau^w = 36.7\%$	100.4	97.31	7.51	2.48	0.53	41.8	4.21	7.79	87.17
Part (c): Positive fixed cost, $\zeta = 0.8w_{baseline}$									
$\tau^c = 1\%$ year $\tau^w = 33\%$	100	100	7.5	2.56	0.60	39.42	4.21	0	0
$\tau^c = 2\%$ year $\tau^w = 34\%$	100.2	99.65	7.5	2.56	0.59	40.04	4.21	1.05	29.74
$\tau^c = 3\%$ year $\tau^w = 34.5\%$	99.91	98.88	7.51	2.54	0.58	39.97	4.21	3.27	56.78
$\tau^c = 3.927\%$ year $\tau^w = 35.8\%$	99.98	97.93	7.5	2.51	0.55	41.33	4.21	5.88	71.05

Table 6: Policy Experiments: Long run credit subsidy effect; endogenous interest rate and lump-sum tax

	Y base (%)	w base (%)	Ent %	K/Y	Share of corp., $\frac{K_c}{K}$	Wealth Gini	r% year	Cost %Y	Subsidy credit (%)
Baseline	100	100	7.5	2.56	0.60	39.42	4.21	0	0
Part (a): No fixed cost, $\zeta = 0$									
$\tau^c = 1\%$ year $\tau^w = 33\%$	100.62	99.62	7.52	2.55	0.58	40.81	4.16	1.81	100
$\tau^c = 2\%$ year $\tau^w = 33\%$	101	98.27	7.64	2.53	0.55	42.31	4.1	3.99	100
$\tau^c = 3\%$ year $\tau^w = 33\%$	101.6	97.11	7.66	2.52	0.54	42.65	4.05	6.65	100
$\tau^c = 3.927\%$ year $\tau^w = 33\%$	102.38	95.8	7.79	2.52	0.51	43.56	3.94	9.68	100
Part (b): Positive fixed cost, $\zeta = 0.4w_{baseline}$									
$\tau^c = 1\%$ year $\tau^w = 33\%$	100	99.82	7.5	2.56	0.59	39.45	4.21	0.41	24
$\tau^c = 2\%$ year $\tau^w = 33\%$	99.96	99.06	7.5	2.56	0.58	40.23	4.19	2.18	71
$\tau^c = 3\%$ year $\tau^w = 33\%$	99.95	97.97	7.49	2.54	0.57	40.95	4.18	4.68	76.59
$\tau^c = 3.927\%$ year $\tau^w = 33\%$	100.37	96.7	7.49	2.54	0.55	42.05	4.12	7.66	86.87
Part (c): Positive fixed cost, $\zeta = 0.8w_{baseline}$									
$\tau^c = 1\%$ year $\tau^w = 33\%$	100	100	7.5	2.56	0.60	39.42	4.21	0	0
$\tau^c = 2\%$ year $\tau^w = 33\%$	99.69	99.53	7.5	2.55	0.59	39.78	4.22	1.07	30
$\tau^c = 3\%$ year $\tau^w = 33\%$	99.76	98.57	7.5	2.55	0.58	40.14	4.2	3.31	56.87
$\tau^c = 3.927\%$ year $\tau^w = 33\%$	99.79	97.6	7.49	2.55	0.57	40.91	4.17	5.57	67.42