Financial Frictions and Productivity: Evidence from Mexico

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Abstract

Mexico exhibits a level of financial development much lower than other Latin American and upper middle income countries. I quantify the aggregate total factor productivity (TFP) losses from resource misallocation arising from financial frictions in Mexico, using a standard model of credit-constrained entrepreneurs with heterogeneous productivities, and detailed, publicly available, data on the entire universe of Mexican establishments. The implied TFP losses are 10 percent, which represent 23 percent of the observed TFP gap between Mexico and the United States. The results suggest that the standard model captures well the role of bank credit in allocating capital across small and medium sized firms, but potentially misses the role of equity markets in financing investments by the largest firms.

Keywords:
Aggregate productivity, bank lending, financial intermediaries.
JEL Classification Numbers: G21, O16, O47.

1. Introduction

Efficient financial institutions are crucial for the accumulation of capital, as well as for the optimal allocation of resources across productive units. When financial markets do not operate efficiently, productive inputs are allocated to those with the deepest pockets, but not necessarily to those with the best ideas. This misallocation of resources is reflected in a lower TFP. The cross-country evidence also suggests that financial development matters for aggregate efficiency, as indicated by the strong correlation between private credit as a share of GDP and TFP seen in Figure 1.

Mexico exhibits a level of financial development much lower than other Latin American and upper middle income countries. Table 1 shows private claims on the private sector by banks and other financial institutions, as a share of GDP, for a group of 151 countries, five sub-groups of countries, and Mexico.[1] Private credit-to-GDP in Mexico is 24 percent—less than half that of the average upper-middle-income country, and the same as the average country in Sub-Saharan Africa. The microeconomic evidence also indicates that Mexico's financial sector does not fare well against comparable countries. According to the World Bank Enterprise Survey (2010), Mexican

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[1] These estimates correspond to the 2013 update of the database on the structure and development of the financial sector described by Beck, et.al. (2000).

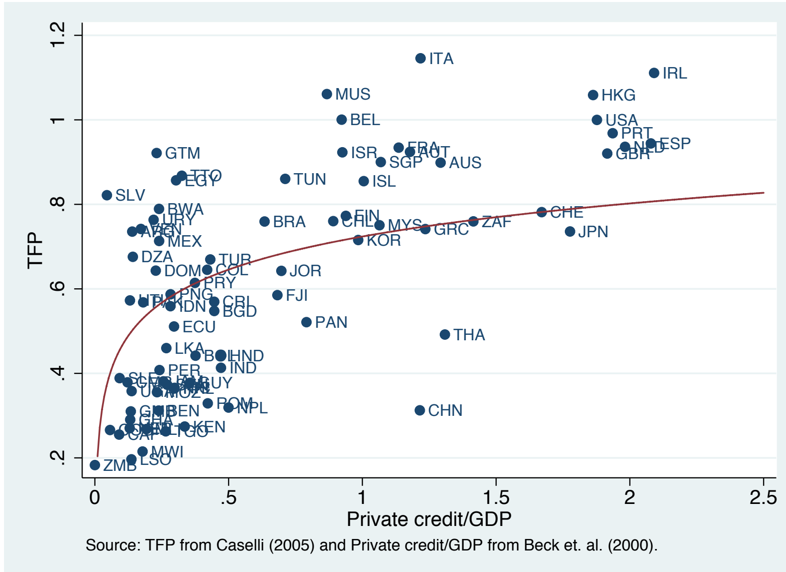

Figure 1: Financial development and TFP around the world.

establishments have lower access to bank credit, and face more stringent collateral constraints and interest rates, compared to their counterparts in similar economies.

I study the role of financial frictions in determining resource misallocation in Mexico. To this end, I take a standard model of heterogeneous entrepreneurs subject to borrowing constraints, and calibrate it using highly detailed, yet publicly available, data on the entire universe of Mexican establishments. In the model, entrepreneurs operate a common technology with decreasing returns to scale, using capital and labor. They differ in their permanent managerial ability, as well as in transitory shocks to their productivity. These entrepreneurs can only borrow in proportion to their wealth, which is accumulated and depleted as they respond to the transitory productivity shocks. Thus, the amount of capital they can use is determined by the amount of funds they can raise in the market.

The baseline calibration implies TFP losses of 10 percent. These losses represent 23 percent

Table 1: Private credit (% of GDP)

Total	57.5
High-income OECD	132.9
High-income non-OECD	81.5
Upper-middle-income	54.1
Latin America	43.2
Sub-Saharan Africa	24.0
Mexico	**24.0**

Source: Beck, et.al. (2000), 2013 update.

of the observed TFP gap between Mexico and the United States, as estimated by Caselli (2005). Through a counterfactual exercise, I find that if Mexico had a level of private credit as a share of GDP comparable to Chile's (.89), it would realize 90 percent of these potential TFP gains.

This article contributes to our understanding of the aggregate effects of a more efficient allocation of credit in countries with low levels of financial development. My findings suggest that the standard model does well at explaining the role of access to bank credit in the efficient allocation of capital, but misses the importance of access to equity markets for the most productive firms in the economy. Further, the evidence suggests that access to credit has a large impact on TFP at very low levels (much lower than Mexico's), but this effect starts to flatten out as access improves.

2. Relation to existing literature

Resource misallocation arising from firm-level distortions in the marginal products of capital and labor has been the subject of much academic inquiry, starting with the work of Restuccia and Rogerson (2008) and Hsieh and Klenow (2009). The latter estimate potential TFP gains of 30-50 percent for China, and 40-60 percent for India, if these economies were to experience the (lower) dispersion in marginal products of capital and labor observed in the United States. Machicado and Birbuet (2012), and Ryzhenkov (2015) use the Hsieh and Klenow (2009) methodology to estimate potential TFP gains from lower misallocation as high as 54 percent for Bolivia, and as high as 300 percent for Ukraine.

The methodology developed by Hsieh and Klenow (2009) has the advantage of being highly tractable and easily implementable, provided that one has a rich cross-section of firm-level data. Unfortunately, it cannot guide our understanding of the sources of misallocation, which can be many and varied, and often leads to very large estimates of potential TFP gains. For instance, Busso, Madrigal and Pages (2013) apply the Hsieh and Klenow methodology to several Latin American countries, and estimate overall potential TFP gains varying from 95 to 140 percent in the case of Mexico. These estimates account for every possible source of the observed dispersion in the marginal products of capital and labor. While there are many studies that apply the more general Hsieh and Klenow methodology, studies on the misallocation effects on aggregate TFP arising specifically from financial frictions using firm-level evidence from developing countries continue to be scarce.

The specific role of financial frictions in shaping the inefficient allocation of resources has been studied by Amaral and Quintin (2010), Buera, et.al. (2011), Midrigan and Xu (2014), and Moll (2014). Using a rich panel of firm-level data for South Korea to calibrate a quantitative model of credit-constrained entrepreneurs, Midrigan and Xu (2014) estimate TFP losses from resource misallocation between 5 and 10 percent. Further, they find that limited access to to equity markets—a feature absent from the standard model—precludes entry into more productive sectors, leading to TFP losses of up to 40 percent. Therefore, the main losses come from the extensive, not the intensive, margin.

My estimates of TFP losses from misallocation—the intensive margin—are in the upper range of those by Midrigan and Xu (2014). This is not surprising, as Mexico exhibits a level of financial development much lower than that of South Korea, where private credit as a share of GDP is 98 percent. In a recent paper, López-Martin (2016) develops an equilibrium model of firm dynamics where improving access to credit induces firms to invest in "knowledge capital", increasing TFP. His strategy is, however, different to the one in this paper: he calibrates the model to match U.S. data and then changes the exogenous parameter governing the degree of financial development so as to match the volume of credit observed in any hypothetical developing economy—he uses Mexico as an example, and the TFP gains he obtains are very close to those in the current paper, at 10.3 percent.[2] When taken together, my results and those in López-Martin (2016) suggest that the standard model used in this paper is enough to capture the role of conventional bank credit. Thus, these results can help researchers decide what extensions to the standard model are relevant and worth pursuing in future efforts.

Bergoeing, et.al. (2002) compare Chile's and Mexico's recoveries from their respective crisis in the early 1980s, and conclude that Chile's much faster recovery can be attributed to earlier policy reforms affecting the banking system and bankruptcy procedures, which had a direct effect on TFP growth. Indeed, as mentioned earlier, private credit as a share of GDP in Chile is 89 percent, higher than the average high-income non-OECD country, and over three times that of Mexico. My results are also consistent with Antunes, et.al. (2013), who find that increased access to credit has larger effects on output than subsidized interest rates. More recently, Gopinath, et.al. (2016) find strong evidence of capital misallocation due to financial frictions in southern Europe consistent with the main story of the standard model of credit constrained entrepreneurs: credit tends to be allocated to firms with higher net worth but not necessarily to the most productive.

3. The data

I use establishment-level statistics from Mexico's 2014 Economic Census, published by the country's main statistical agency (INEGI, by its Spanish acronym). The census covers all establishments with a physical address that operated in 2013. These statistics are publicly available via their webpage (www.inegi.org.mx).[3] Table 2 shows the employment size distribution of establishments, along with INEGI's size classifications. Most of the establishments belong to the "micro" category—those with less than 10 employees.

Table 3 contains access to, and main sources of credit by size category, and overall. Only 16.5 percent of all establishments have access to some form of financing. This share is driven by the high concentration of micro establishments in the data, where only 15.8 percent have access to credit. This figure increases considerably as one moves up the size distribution. Notice that banks are the most prominent source of credit, even among the smallest establishments, being used by 40-75 percent of establishments with access to financing.

The average establishment does not have access to credit. Micro establishments rely more on friends and family, savings cooperatives, loan companies, and government loans, relative to larger firms. The typical establishment using bank credit has 14 employees, which falls in INEGI's "small" category, whereas the average establishment issuing debt obligations has 128 employees. Last, INEGI also reports that the purchase of new equipment, setup costs, and the purchase of intermediate inputs are the three main uses of bank credit.

[2]In other words, the question in López-Martin (2016) is "what would be the losses to the U.S. if it had a level of financial development similar to Mexico's". The question in my paper is "taking other distortions as given, what are the potential gains to Mexico of improving its level of financial development?". One of the useful insights from my results is that perfect access to credit is not necessary to realize most of those potential gains. This may be due, in part, because other distortions limit the potential gains from financial development.

[3]Access to the raw micro data is also possible by filling a request form, also available online. With the exception of the size of the largest establishments—which I obtained via restricted access to the raw data—all the data I use in this study comes from the publicly available statistics.

Table 2: Size distribution of establishments.

Size	INEGI classification	Percentage
<10	Micro	94.32
11 to 50	Small	4.65
51 to 250	Medium	0.84
> 250	Large	0.19

Source: INEGI, 2014 Economic Census.

Table 3: Access and main sources of finance among Mexican establishments, by size (%)

	Access	Banks	Fr.&Fam.	Savings Coop.	Suppliers	Loan Co.
Overall	**16.5**	**43.1**	**15.0**	**19.5**	**11.2**	**5.9**
0 to 10	15.8	39.4	16.4	21.4	10.6	6.1
11 to 50	28.4	78.5	2.8	2.2	15.1	4.6
51 to 250	38.7	79.9	0.2	0.8	22.1	3.1
> 250	35.9	75.0	0.1	0.6	20.5	2.8

Source: INEGI, 2014 Economic Census.

4. Environment

The model is the baseline version of the environment with heterogeneous entrepreneurs with borrowing constraints described by Buera, et.al. (2015). Time is discrete and infinite. There is a continuum of hand-to-mouth workers of mass η, each of whom inelastically provides one unit of effective labor. A unit continuum of firms operated by managers with heterogeneous productivities use capital and labor to produce a homogeneous good. Output by firm i at time t is given by

$$Y_{it} = \left(Z_i \exp(\epsilon_{it})\right)^{1-\theta} \left(K_{it}^{\alpha} N_{it}^{1-\alpha}\right)^{\theta}, \tag{1}$$

where Z_i is the entrepreneur's permanent ability, and ϵ_{it} is an idiosyncratic, time-varying productivity shock. The amount of capital and the number of workers hired by the firm are given by K_{it} and N_{it}. The parameter θ measures the degree of decreasing returns to scale, as in Lucas (1978), while α represents the capital share of output. The entrepreneur's productivity shocks follow a discrete-state Markov chain with transition probability function $Pr\left(\epsilon_{t+1} = \epsilon' | \epsilon_t = \epsilon\right) = f(\epsilon', \epsilon)$, and a unique stationary distribution $\tilde{f}(\epsilon)$. The permanent component, Z, is distributed according to some function $G(Z) : \mathbb{R}_+ \rightarrow [0, 1]$.

The economy is small and open, and borrowers and savers face an exogenous, risk-free interest rate r. Firms have to purchase capital before production takes place, and have access to intra-period debt. They can borrow only in proportion to their current wealth, which is used as collateral. Specifically, a manager with total assets $A > 0$, can spend no more than λA, where $\lambda \in [1, \infty)$. If $\lambda = 1$ the entrepreneur has no access to capital markets, while if $\lambda = \infty$, the entrepreneur has perfect access.

4.1. Static problem

The entrepreneurs' static problem is to choose capital and labor so as to solve

$$\Pi(A, Z, \epsilon) \equiv \max_{K,N} \left(K^{\alpha} N^{1-\alpha}\right)^{\theta} \left(Z \exp(\epsilon)\right)^{1-\theta} - (r+\delta) K - wN, \text{ s.t. } K \leq \lambda A.$$

Let $n \equiv N/Z$, and $k \equiv K/Z$. In the intensive form, given $a = A/Z$ and (r, w), choose (n, k) to solve

$$\pi(a, \epsilon) \equiv \max_{n,k} \left(k^{\alpha} n^{1-\alpha}\right)^{\theta} \exp((1-\theta)\epsilon) - (r+\delta) k - wn, \text{ s.t. } k \leq \lambda a. \tag{2}$$

Let $\mu(a, \epsilon)$ denote the Lagrange multiplier on the firm's collateral constraint, and define the interest rate $\widetilde{r}(a, \epsilon) \equiv r + \mu(a, \epsilon)$. Midrigan and Xu (2014) refer to $\widetilde{r}(a, \epsilon)$ as the *shadow cost of funds*. If the collateral constraint does not bind, then $\mu(a, \epsilon) = 0$. The first order conditions for the problem in (2) satisfy

$$MP_k = r + \mu(a, \epsilon), \tag{3}$$
$$MP_n = w, \tag{4}$$
$$k \leq \lambda a, \text{ with equality if } \tilde{r}(a, \epsilon) > r. \tag{5}$$

Equation (3) makes it clear that as long the credit constraint binds (and thus $\mu(a, \epsilon) > 0$), there will be dispersion in the marginal product of capital across producers, thus creating misallocation of capital. It follows that the choices of capital and labor (through the capital-labor ratio) are distorted whenever entrepreneurs are constrained by their borrowing limit. Notice that the shadow cost of funds will be higher the poorer an entrepreneur is relative to his productivity. Another way to think about the shadow cost of funds is that it represents the highest interest rate an entrepreneur would be willing to pay to operate at its current scale. Thus, formulating financial frictions as a collateral constraint rationalizes the high interest rates paid by some entrepreneurs in developing countries, like those reported by Banerjee and Duflo (2005), without explicitly modeling them. Further, this formulation of credit constraints is a good depiction of the Mexican economy for two reasons. First, as reported in Table 1, bank credit is the most prominent source of credit, even for the smallest firms.[4] Second, according to INEGI, purchases of equipment is the number one usage of borrowed funds among Mexican establishments.

4.2. Inter-temporal choice

Because all debt is intra-period, there is no debt accumulation. The dynamic problem of the entrepreneur is a variant of the classic income fluctuations problem: He increases and depletes his stock of assets in response to the transitory shocks. Because he needs a positive wealth to use as collateral, the natural lower bound for assets is zero.

[4]The aggregate data on private credit as a share of GDP includes regular commercial banks, as well financial institutions traditionally focused on smaller firms, such as microfinance banks, and savings cooperatives.

Since profits, output, as well as the firm policies for capital and labor all exhibit CRS in (Z, A), we can rescale all variables in the dynamic program for the entrepreneur by his permanent managerial ability, Z. In the rescaled program, each entrepreneur is characterized by his individual state, the pair (a, ϵ). I assume that $\beta(1 + r) < 1$, as in Aiyagari (1994). That is, entrepreneurs are relatively impatient. This assumption, together with CRRA utility, ensures that there is an upper bound on the desired level of asset holdings, call it a_{max}.

The entrepreneur's dynamic program is then

$$v(a, \epsilon) = \max_{c,a'} \left\{ \log(c) + \beta \sum_{\epsilon'} v\left(a', \epsilon'\right) f(\epsilon', \epsilon), \right\}, \tag{6}$$

s.t

$$a' = (1 + r)a + \pi(a, \epsilon) - c; \qquad a' \geq 0. \tag{7}$$

The optimal consumption policy satisfies a standard Euler equation,

$$\frac{1}{c} = \beta \sum_{\epsilon'} (1 + r + \mu') \frac{1}{c'} f(\epsilon', \epsilon). \tag{8}$$

The optimal savings policy, as well as the shadow cost of funds for entrepreneurs with high and low productivity shocks are depicted in Figure 2. Poor entrepreneurs with a high shock exhibit high savings rates, which are induced by a high shadow cost of funds. This occurs because the shadow cost of funds represents the marginal product of capital, which is higher for poor but productive entrepreneurs, inducing them to save to overcome their borrowing constraints.

The aggregate state of the economy is the cross-sectional distribution of entrepreneurs across states, call it $\psi(a, \epsilon)$. Define the compact set $\mathcal{A} \equiv [0, a_{max}]$ of possible rescaled asset holdings, and let the countable set $\mathcal{E}$ be the set of all possible individual shocks. The state space is then the product $\mathcal{S} \equiv \mathcal{A} \times \mathcal{E}$, with typical subset $s \equiv (\tilde{a} \times \tilde{\epsilon})$.

Let $\mathcal{B}$ denote the collection of all subsets of $\mathcal{S}$, and define the transition function Q :S$\times\mathcal{B} \to [0, 1]$, that is, the probability that an individual with current state (a, ϵ) transits into the set $(\tilde{a} \times \tilde{\epsilon})$ next period,

$$Q((a, \epsilon), \tilde{a} \times \tilde{\epsilon}) = \sum_{\epsilon' \in \tilde{\epsilon}} I\{g(a, \epsilon) \in \tilde{a}\} f(\epsilon', \epsilon), \tag{9}$$

where $I(\cdot)$ is the indicator function and $g(a, \epsilon)$ is the optimal savings policy. Then, the cross-sectional distribution of entrepreneurs over states (a, ϵ) evolves according to

$$\psi_{t+1}(\tilde{a} \times \tilde{\epsilon}) = \int_{\mathcal{A}\times\mathcal{E}} Q((a, \epsilon), \tilde{a} \times \tilde{\epsilon}) d\psi_t(a, \epsilon). \tag{10}$$

4.3. Equilibrium

Given a unit-continuum of entrepreneurs, a continuum η of workers, a world interest rate r, an invariant distribution of permanent managerial abilities $G(Z)$, and a transition function $f(\epsilon', \epsilon)$, with an associated unique stationary density of transitory productivity shocks, $\tilde{f}(\epsilon)$, a stationary recursive competitive equilibrium consists of capital and labor policy functions $k(a, \epsilon)$ and $n(a, \epsilon)$,

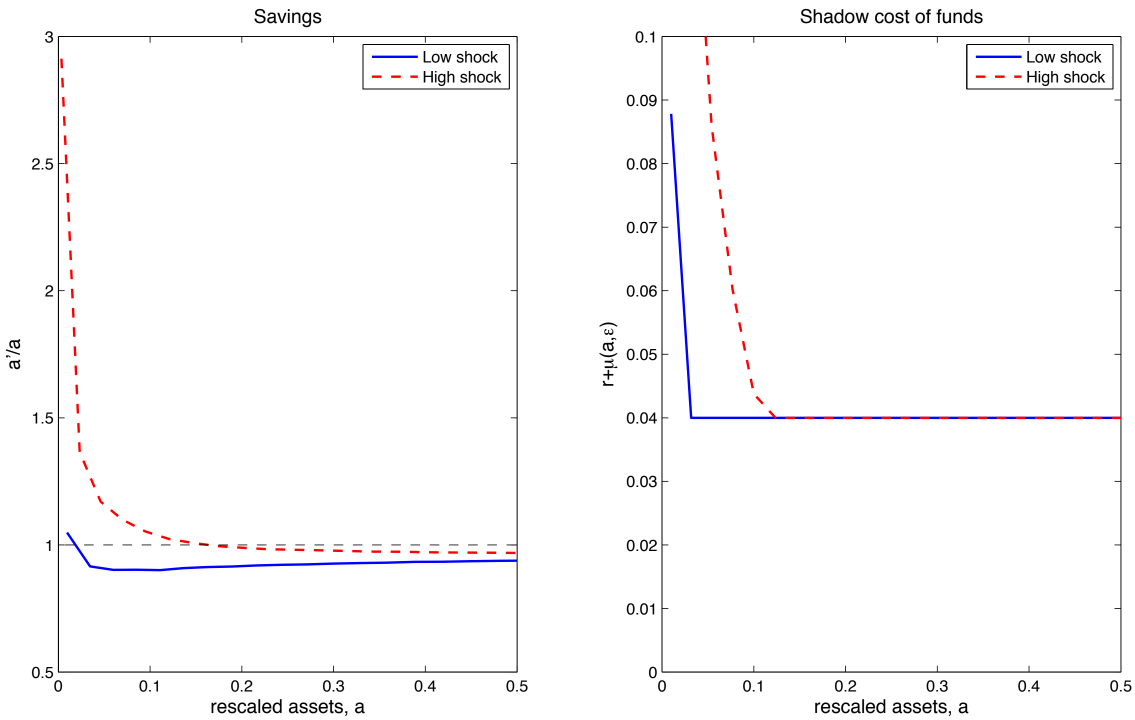

Figure 2: Savings and shadow cost of funds.

a consumption policy function $c^*(a,\epsilon)$, with its associated savings policy $a' = g(a,\epsilon)$, a wage rate w^*, and an invariant measure $\psi(a,\epsilon)$, such that,
1. The policy functions $k(a,\epsilon)$, $n(a,\epsilon)$ and $b(a,\epsilon)$ solve the entrepreneur's static problem;
2. The policy functions $c^*(a,\epsilon)$ and $a' = g(a,\epsilon)$ solve the entrepreneur's inter-temporal problem;
3. The stationary measure $\psi(a,\epsilon)$ is induced by $(f,\mathcal{E})$ and $g(a,\epsilon)$;
4. The labor market clears;
5. The goods market clears.

4.4. Calculating TFP, and losses from financial frictions

The following discussion borrows from Hsieh and Klenow (2009) and Midrigan and Xu (2014). Let $E_i = Z_i \exp(\epsilon_i)$ denote the total productivity of entrepreneur i. Consider the centralized problem of allocating the aggregate stocks of capital and labor across a unit continuum of firms, so as to maximize total output.

$$\max_{K_i,N_i} Y = \int_0^1 E_i^{1-\theta}(K_i^{\alpha}N_i^{1-\alpha})^{\theta}\mathrm{d}i,$$

subject to

$$K = \int_0^1 K_i \mathrm{d}i, \qquad N = \int_0^1 N_i \mathrm{d}i.$$

Let $\bar{E} = \int_0^1 E_j \mathrm{d}j$. In the absence of frictions, capital and labor will be allocated so as to equalize returns to factors across firms, which satisfies, for all i,

$$K_i = \frac{E_i}{\bar{E}}K, \qquad N_i = \frac{E_i}{\bar{E}}N.$$

Aggregate output is then equal to

$$Y = TFP(K^{\alpha}N^{1-\alpha})^{\theta},$$

where

$$TFP = \frac{Y}{(K^{\alpha}N^{1-\alpha})^{\theta}} = \bar{E}^{1-\theta}.$$

Now consider an economy where firms are financially constrained as described in the previous section. The labor and capital allocations of the constrained entrepreneurs will be given by

$$K_i = \omega_i^k \frac{E_i}{\bar{E}}K, \qquad N_i = \omega_i^n \frac{E_i}{\bar{E}}N.$$

The wedges $\omega_i^k, \omega_i^n \in [0,1]$ measure the inefficiency in the allocation of resources due to financial frictions, and are given by

$$\omega_i^k = \left[\frac{r+\delta}{\widetilde{r}_i+\delta}\right]^{\frac{1-\theta(1-\alpha)}{1-\theta}}; \tag{11}$$

Table 4: Summary statistics.

Average establishment size	5.5
Largest establishment size	12,226
Smallest establishment size	1
Share of micro establishments	.94
Share of small establishments	.05
Share of medium establishments	.008
Share of large establishments	.002
Relative average capital size of micro establishments	.10
Relative average capital size of small establishments	2
Relative average capital size of medium establishments	17.23
Relative average capital size of large establishments	377
Capital-output ratio	1.9
Bank credit/GDP	.24
External financing ($N > 5$)	.15

$$\omega_i^n = \left[\frac{r+\delta}{\widetilde{r}_i+\delta}\right]^{\frac{\theta\alpha}{1-\theta}}. \tag{12}$$

Aggregate productivity is then

$$TFP = \frac{\int_0^1 \omega_i^\theta E_i di}{\bar{E}^\theta}, \tag{13}$$

where $\omega_i = \left(\omega_i^k\right)^\alpha \left(\omega_i^n\right)^{1-\alpha}$ is the TFP wedge for producer i. In other words, the effective TFP of producer i is $\omega_i E_i$, which is weakly less than E_i, since $\omega_i \in (0,1]$. Clearly, as long as there are some entrepreneurs constrained by their borrowing limit, there will be TFP losses from financial frictions.

5. Parameterization and calibration

5.1. Baseline calibration

Each period is a year. Table 4 contains summary statistics used to calibrate and test the model. There are two sets of parameters: assigned and calibrated. The assigned parameters are either taken from related literature dealing with data from Mexico, or reliable official estimates of them exist.

Sources and values for the assigned parameters are presented in Table 5. A crucial parameter in the analysis is the capital share of income, α. As noted by Gollin (2002), using traditional National Income and Product Accounts (NIPA) to estimate factor shares in developing countries tends to

Table 5: Assigned parameter values.

Parameter	Definition	Value	Source
α	capital share	0.3, 0.4	Bergoeing, et.al. (2002), García Verdú (2005)
r	risk-free rate	0.04	Mexico's 1-year Treasury bill rate
θ	span of control	0.76	Leal-Ordóñez (2014)
δ	depreciation rate	0.07	INEGI, 2014 Economic Census
η	measure of workers	5.5	Average establishment size

over-estimate the role of capital, since it misses most self-employed and family workers, who tend to be a large fraction of the labor force. He then shows that if there are sufficient data to correct for such measurement error, capital shares of income are much closer to that in the U.S., 0.30. In their comparison of Mexico and Chile in the 1980s, Bergoenig et.al. (2002) use a value of $\alpha = 0.30$ for this very reason. In the specific case of Mexico, García Verdú (2005) uses household survey data from 1968 to 2002 to estimate factor shares, and shows that estimates of α are fairly stable at around 0.40—much closer to the U.S. value than the 0.60 obtained from NIPA data. For robustness purposes, I perform alternative calibrations for $\alpha = 0.30$ and $\alpha = 0.40$.

The value for the small open economy risk-free rate is set at 4 percent, consistent with Mexico's 364-day Treasury bill rate. The parameter governing the degree of decreasing returns to scale, θ, is taken from Leal-Ordóñez (2014), who uses a deterministic, but similar, environment to study firm's selection into informality in Mexico using the Economic Census data. The depreciation rate comes from INEGI's own calculations. Last, given the assumption of a unit-continuum of entrepreneurs, the mass of workers is set equal to the average establishment size, which is 5.5 employees.

The rest of the parameters are calibrated jointly by requiring that the model accounts for establishment-level facts from Mexico's Economic Census, as well as a set of aggregate moments describing the level of financial development in Mexico. Table 6 contains calibrated parameter values, along with the corresponding targeted moments. Notice that the calibrated parameter values across both values of α vary only modestly.

I assume the permanent productivity component, Z, is distributed according to a truncated Pareto distribution. Specifically,

$$Pr(Z^{1-\theta} \leq z) = \frac{1 - \left(\frac{Z_L^{1-\theta}}{z}\right)^s}{1 - \left(\frac{Z_L^{1-\theta}}{Z_H^{1-\theta}}\right)^s},$$

Where Z_L and Z_H represent the lower bounds for the permanent productivity component, and s is the shape parameter. Leal-Ordóñez (2014) shows that this functional form matches the employment size distribution of Mexican establishment well.[5] I follow Restuccia and Rogerson (2008), and calibrate the support parameters so as to match the range of firm sizes.

[5]My calibrated parameters for the Pareto distribution differ from those by Leal-Ordoñez (2014) mainly because in his model there are two scale distortions absent in my environment: an informality choice, and an output tax on those establishments choosing to be formal.

Table 6: Calibrated parameter values.

Parameter	Definition	Value ($\alpha = 0.3$)	Value ($\alpha = 0.4$)	Target
$[Z_L, Z_H]$	Pareto bounds	[2, 9.8]	[2, 9.77]	Size range
s	Pareto shape	2.07	2.20	Share of est. of size $N \leq 10$
ρ_ϵ	persistence of shocks	0.68	0.61	Rel. avg. K of micro est.
σ_ϵ	std. dev. of shocks	0.44	0.40	Rel. avg. K of medium est.
β	discount factor	0.93	0.95	Capital-output ratio
λ	collateral constraint	1.69	1.84	Credit/GDP

I assume that the transitory productivity shock ϵ_{it} follows an AR(1) process with Gaussian disturbances, which I then approximate with a finite state Markov chain using the Tauchen (1986) method. I solve the model via value function iteration using the endogenous grid method described by Barillas and Fernandez-Villaverde (2007). I choose the persistence and volatility of the transitory shocks to match features of the distribution of average capital across establishment sizes relative to the national average. This strategy exploits the cross-sectional nature of the data, circumventing partially the lack of a time-series dimension. This is possible because, in the model, capital is proportional to wealth, which is accumulated and depleted in response to the transitory shocks.

I rely on the estimates of Mexico's capital-output ratio by Restuccia (2008) and Leal-Ordóñez (2014) to calibrate the discount factor, β. The type of financial friction present in the model most closely resembles loans by banks and other financial institutions. Thus, I choose the collateral constraint coefficient, λ, to match Mexico's private credit by banks and other financial institutions as a percentage of GDP, which I take from the estimates of Beck, et.al. (2000) shown in Table 1.[6]

5.2. Discussion

Calibration results for targeted moments are in Table 7.[7] The model with $\alpha = 0.30$ matches well the employment size distribution of establishments, as well as all targeted aggregate moments. The model with $\alpha = 0.40$ performs just as well at matching the establishment-level facts, but over-estimates the capital-output ratio, as well as credit as a percentage of GDP. This makes sense, since a higher value of α in the production function implies a higher demand for capital. Given its superior performance, the rest of the discussion focuses on the model with $\alpha = 0.30$.

In Table 8, I report results for some relevant non-targeted moments. According to the World Bank Enterprise Survey (2010), the percentage of fixed assets financed with credit from banks and other financial institutions by Mexican establishments is, on average, 15 percent. Because the World Bank Enterprise Survey only considers establishments with 5 employees or more, I restrict

[6]This measure of access to credit does not include access to equity markets, which is also available in the dataset by Beck, et.al. (2000).

[7]These results are robust to whether one targets the left or the right tail of the employment size distribution of establishments.

Table 7: Calibration results: Targeted moments.

	Data	Model ($\alpha = .3$)	Model ($\alpha = .4$)
Size range (scaled by $1 - \theta$)	9.5	9.5	9.6
Share of micro establishments	.94	.9	.9
Rel. avg. capital of micro establishments	.10	.25	.25
Rel. avg. capital of medium establishments	17.23	17.23	17.20
Capital-output ratio	1.9	1.9	2.67
Private credit (% of GDP)	.24	.24	.32

my attention to their model counterparts and estimate the percentage of capital financed with external resources at 14 percent—a close match.

The model successfully matches the relative average capital of medium firms. However, the model cannot replicate the observed extreme disparity in relative capital sizes. In the data (model), the smallest establishments have, on average, only 0.10 (0.25) times as much capital as the average one. In contrast, the largest establishments have, on average, 377 (51) times as much capital as the average one.

One reason behind the thin and long right tail of the distribution of relative capital sizes is the high concentration of stock market activity in Mexico. Table 9 shows stock market capitalization as a share of GDP, as well as the number of firms listed per 10,000 population, for the same groups of countries as in Table 1. Although Mexico's stock market capitalization is slightly lower than that of other upper-middle-income countries, it is still higher than the average Latin American country. However, the number of firms listed in Mexico is considerably smaller than any of the average of the groups in the sample. That is, the value of Mexico's stock market is concentrated among a few firms. Further, according to INEGI's 2014 Economic Census, only 0.1 percent of Mexican establishments issue debt. I interpret this evidence, along with the model's failure to match the size of the relative capital stock of the largest firms, as a nod to the main result in Midrigan and Xu (2014), namely, that the most productive firms in the economy use equity markets—as opposed to traditional credit—to finance long-term, large investments. In a more stylized model, Zhang and Hou (2015) also predict that more productive firms prefer to issue bonds to finance their investments. The standard model of credit-constrained entrepreneurs, however, does not provide an explicit role for equity markets, which may explain its failure to replicate the right tail of the distribution of capital across establishments.

The model predicts aggregate TFP losses of 10.24 percent, when compared to a perfect-credit benchmark. These losses represent 23 percent of the TFP gap between Mexico and the United States, as estimated by Caselli (2005). In Table 10, I trace out the effects of different values of λ on TFP, capital per worker, and private credit over GDP, keeping the rest of the parameters at their baseline values. The results indicate that if Mexico had a level of financial development consistent with a private credit-to-GDP ratio of 0.91 (which is just slightly higher than Chile's 0.89), it would realize over 90 percent of the potential TFP gains implied by the perfect credit benchmark. Mexico is, of course, a country where many other distortions interact with access to credit, so in performing this counterfactual I assume every other distortion, institutional or otherwise, remains the same.

Table 8: Calibration results: Non-targeted moments.

	Data	Model
External financing ($N >= 5$)	.15	.14
Share of small establishments	.05	.08
Share of medium establishments	.008	.02
Share of large establishments	.002	5.9e-4
Rel. avg. capital of small establishments	2	4
Rel. avg. capital of large establishments	377	51

Table 9: Stock market capitalization and number of firms listed.

Region	Stock Mkt. Cap (%GDP)	Firms listed (per 10K pop.)
Total	49.52	2716.31
High-income OECD	62.16	3510.91
High-income non-OECD	88.26	7040.94
Upper-middle-income	43.26	1914.21
Latin America	31.88	576.08
Sub-Saharan Africa	34.36	764.68
Mexico	**37.44**	**107.24**

Source: Beck, et.al. (2000), 2013 update.

Table 10: The effects of the collateral constraint coefficient (baseline λ=1.69).

	$\lambda = 1$	$\lambda = 4$	$\lambda = 6$	$\lambda = 10$
TFP (relative to baseline)	.9071	1.0824	1.0963	1.1017
Capital per worker (relative to baseline)	.8929	1.0946	1.1108	1.1173
Credit/GDP (baseline value = .24)	-.38	.79	.91	.99

Table 11: Sensitivity analysis: the persistence of shocks, ρ (baseline ρ=.68).

	$\rho = .1$	$\rho = .25$	$\rho = .5$	$\rho = .75$	$\rho = .95$
TFP (relative to first best)	.9133	.9118	.9099	.9055	.9099

In a recent paper, Moll (2014) argues that the persistence of temporary productivity shocks (ρ in the model) is a crucial parameter in the determination of TFP losses from financial frictions. In a more stylized linear economy with only capital, he shows that low persistence amplifies the productivity losses from financial frictions in the steady state. The reason is that when shocks are close to i.i.d. (a low value of ρ), entrepreneurs have little incentive to save for prolonged periods of time, which impedes them from growing out of their borrowing constraints by accumulating wealth. Because my calibration of ρ depends on the cross-sectional distribution of capital, it is natural to explore the implied TFP losses for a wide range of values of ρ. In Table 11, I report the TFP losses (relative to a first-best allocation) for values of ρ ranging from 0.1 to 0.95. The implied TFP losses exhibit small variation compared to the baseline calibration, which reaffirms the robustness of my results. These results are driven partially by the inclusion of a permanent productivity component, as in Midrigan and Xu (2014), so even when transitory shocks are close to i.i.d., total productivity orbits around the entrepreneur's permanent ability. Excluding the permanent component in my numerical exercises leads to an unrealistic establishment size distribution.

If the permanent productivity component is such a strong force behind wealth accumulation, why is it then that misallocation of capital persists at the steady state? The answer lies in the nature of entrepreneurs as both firm owners and consumers—more specifically, impatient consumers. The standard model is basically an Aiyagari (1994) economy where the idiosyncratic income shocks arise from random fluctuations in the profitability of each entrepreneur's venture. Therefore, entrepreneurial savings during good times are more than purely precautionary: they need that wealth to grow out of their borrowing constraints. Accordingly, during rainy days, they tend to deplete whatever wealth they have accumulated in order to smooth their consumption. At the steady state, the distribution of wealth is invariant, but individual entrepreneurs are churning throughout the entire distribution over time. This common feature of a large class of models that build on Bewley (1977)—to which the Aiyagari (1994) model belongs—is often referred to as "American dream, American nightmare."

Last, the model predicts a relatively flat relationship between access to credit and TFP. In Figure 3, I show the results from the counterfactual in Table 10, along with the raw data on credit-to-GDP and TFP used as motivation in Figure 1. The dashed line corresponds to the equilibrium counterfactuals from the model, while the solid line is fitted by running an OLS regression of TFP (relative to Mexico), against the log of credit-to-GDP, plus a constant term. The flat relationship between financial development and TFP starts to kick in at just above Mexico's level of credit-to-GDP. Thus, a safe interpretation of the equilibrium counterfactuals is that they represent an approximation of the slope of the relationship between credit-to-GDP and TFP in a close neighborhood of the baseline calibration values.

6. Conclusion and speculations

I find that improving access to credit in Mexico enough to achieve a private credit-to-GDP ratio similar to Chile's realizes most of the TFP gains from better allocation implied by a perfect credit

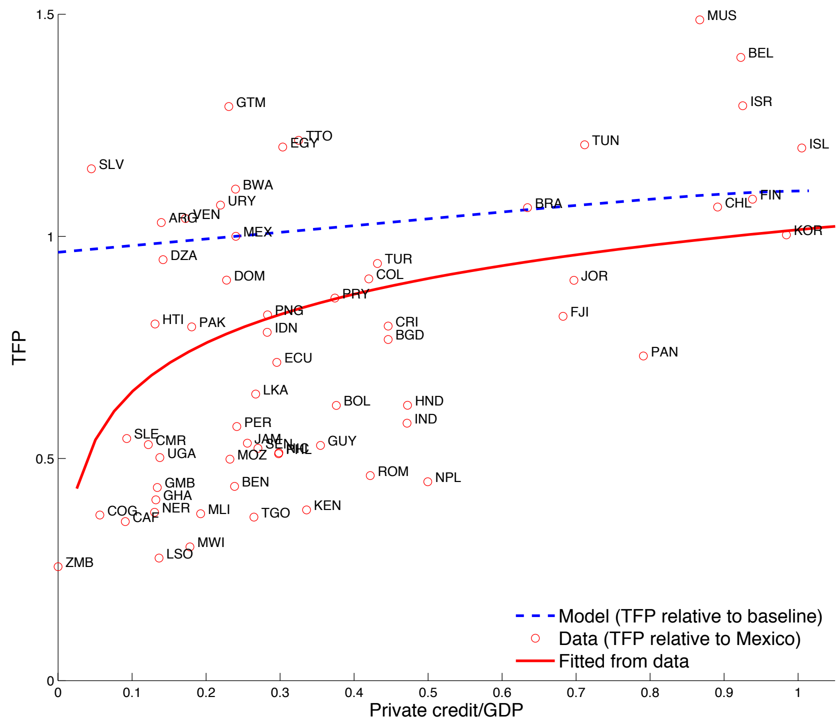

Figure 3: Financial development and TFP: Data and model.

benchmark. That is, perfect access to credit is not necessary to dissolve the TFP losses from limited access.

The model fails to replicate the extreme disparity in relative capital sizes across establishments. The results suggest that the standard model captures well the role of bank credit in allocating capital across firms, but potentially misses the role of equity markets in financing large investments. A large and unproductive informal sector with a low demand for capital could also explain the diminutive relative size of the capital stock among the smallest establishments.

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