# The Macroeconomic Consequences of Subsistence Self-Employment*

Juan Herreño
UC San Diego

Sergio Ocampo
Western University

This Version: June 22, 2022

**Abstract**

We evaluate the aggregate effects of expansions of credit supply in environments where subsistence self-employment is prevalent. We extend a standard macro development model to include unemployment risk, which becomes a key driver of selection into self-employment. The model is consistent with the joint distribution of earnings and occupations, the reaction of wages to labor demand shocks, and the small effects of expansions in the supply of microloans on the earnings of the self-employed. We find that the elasticity of aggregate output to expansions in credit supply is proportional to the elasticity individual earnings. This is because of the muted effects of wages in general equilibrium in the presence of subsistence self-employment. We also consider variations on the implementation of the credit expansion and the introduction of targeted transfers. The effects on total factor productivity (TFP) are ambiguous and depend on the targeting and generosity of the policies, with those that encourage self-employment lowering TFP.

**JEL:** E44, J25, O11, O16, O17
**Keywords:** Self-Employment, Unemployment, Development, Micro-Finance

*Herreño: juanherreno@ucsd.edu; Web: `https://sites.google.com/view/juanherreno`.
Ocampo: socampod@uwo.ca; Web: `https://sites.google.com/site/sergiocampod`.
We thank Luigi Bocola, Sylvain Catherine, Julieta Caunedo, Kevin Donovan, Charles Gottlieb, Fatih Guvenen, Nir Jaimovich, Gueorgui Kambourov, Loukas Karabarbounis, Supreet Kaur, Burhan Kuruscu, David Lagakos, Jennifer La'O, Lance Lochner, Benjamin Moll, Monica Morlacco, Emily Moschini, Chris Moser, Emi Nakamura, Paolo Piacquadio, Tommaso Porzio, Kjetil Storesletten, Jón Steinsson, Dominic Smith, Thomas Winberry, and seminar participants at various institutions for valuable comments and discussions. This work was supported by the Institute for New Economic Thinking. A previous version of this paper circulated under the title "Self-Employment and Development."

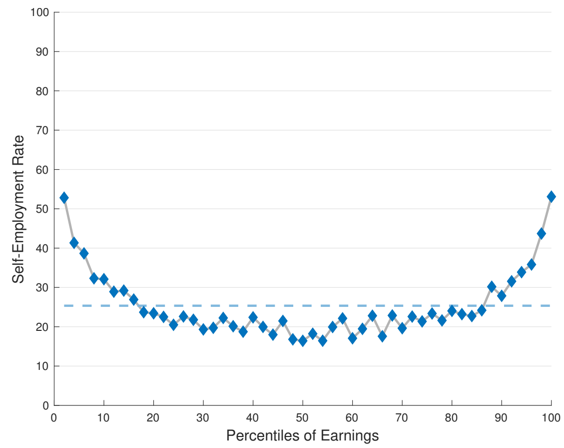
Self-employment rates are high in developing countries, particularly among the poor (Gollin, 2008; Poschke, 2013a,b, 2019). The subsistence concerns faced by poor individuals often push them to become self-employed, starting businesses that do not grow and generate little value added (Banerjee and Duflo, 2011). These individuals are referred to as *"subsistence entrepreneurs"* (Schoar, 2010). In this context, policymakers create programs aimed at fostering growth and reducing poverty, for example, introducing credit expansions and conditional and unconditional transfers. Many of these programs target self-employed individuals, changing the incentives to become self-employed.

We study the aggregate effects of micro credit expansions in contexts where subsistence self-employment is prevalent. Specifically, we compute the elasticity of aggregate output and total factor productivity (TFP) to a shift in the supply of credit to the self-employed. We do so using an occupational choice model with idiosyncratic income risk, financial frictions, and labor frictions that introduce unemployment risk for individuals. In equilibrium, self-employment is chosen by high-productivity individuals but also by poor unemployed individuals who use it as a source of self-insurance. In this way, introducing unemployment risk together with financial frictions allows *subsistence* concerns to dominate the selection into self-employment among the poor. These occupational sorting incentives imply that self-employment rates in the model are highest among the rich and the poor, exhibiting a U-shaped pattern along the earnings distribution as is the case in the data, see Figure 1.

We find that the aggregate elasticity of output to increasing credit availability is proportional to the elasticity of individual self-employment earnings, linking the aggregate (macro) and micro response of the economy to an increase in lending. We reach this conclusion in two steps. First, we simulate an expansion of credit availability of the same magnitude as in loans provided by Compartamos Banco in Mexico, studied by Angelucci, Karlan, and Zinman (2015), and find that our model replicates the micro effects on earnings in the data. Second, we compare the average micro effects with the macro effects of the same reform, concluding that they are proportional.

The reason why the macro and micro elasticities are similar in size is the muted response of wages to the reform we consider. An increase in credit supply shifts labor demand in the salaried-work sector of the economy. The response of wages depends on the price elasticity at which the economy supplies more labor to this sector. In the presence of subsistence self-employment, this elasticity is large, even though the intensive-margin labor supply of individuals is perfectly inelastic. The small wage

Figure 1: Self-Employment and Earnings




***Note:*** *The figure shows the joint distribution of income and self-employment for the U.S. and nine developing economies for which we had access to household surveys (Azerbaijan, Albania, Bulgaria, Brazil, Colombia, Mexico, Peru, Serbia, and South Africa). We compute self-employment rates in 50 equal-sized quantiles of the income distribution. The underlying data come from household surveys for the developing countries. We report the profile for each individual country in Figure D.2.*

response after labor demand shocks in the model is consistent with experimental and quasi-experimental evidence of the presence of slack in labor markets where self-employment is prevalent, as in Breza, Kaur, and Shamdasani (2021) and Muralidharan, Niehaus, and Sukhtankar (2017). Our results show that the response of wages to labor demand shocks is an informative cross-sectional moment when determining the strength of the general equilibrium effects of policies.

We also use the model to measure the effects of an increase in credit supply on TFP and welfare. TFP increases due to the differential effect of the policy on the occupational choices of low- and high-productivity individuals. Productive individuals disproportionately benefit from additional credit, leading capital and labor to be reallocated into more productive hands. The self-employment rate decreases, as more labor is concentrated in more productive firms. The policy creates small welfare improvements. Average welfare, measured in consumption equivalent units, increases by almost 0.1 percent.

Finally, we consider variations in policy design by changing the generosity of credit and the implementation of targeted cash transfers, following policy designs from developing countries described in Meager (2019) and Banerjee, Niehaus, and Suri (2019). We find that different policy designs lead to similar increases in aggregate output, but differ in the response of TFP.[1] These differences are driven by small changes in individual selection into self-employment. For instance, providing loans at market rates increases productivity, while providing subsidized loans decreases it. The difference lies in how different policies differentially affect the occupational choices of high- and low-productivity individuals. Loans at market rates benefit high-productivity individuals the most because they have higher rates of return, while subsidized loans benefit low-productivity individuals the most, inducing negative selection into self-employment. Similar results apply to cash transfers targeted exclusively to the unemployed vis-a-vis broader transfers that reach unemployed and self-employed individuals.

The model we use to reach these findings incorporates unemployment risk into an occupational choice model in the spirit of Buera, Kaboski, and Shin (2015). Agents can be employed, self-employed, or unemployed. Employed and self-employed agents are subject to income fluctuations generated by idiosyncratic productivity shocks. Labor income depends on individual labor productivity. Self-employment income depends on productivity and wealth because of financial frictions. While agents can become self-employed or unemployed at will (by starting their own business or quitting their job), they can only become employed after receiving a job offer, which arrives stochastically. We calibrate the model to match workforce composition and income fluctuations from Mexican longitudinal household data.

The model highlights how the interplay between labor market and financial frictions impacts the decision of individuals to become self-employed. For a risk-averse individual, unemployment becomes intolerable whenever they have low assets and no effective access to credit. To avoid the risk of failing to find a job, poor unemployed individuals choose to self-insure by becoming self-employed even when they lack the productivity or the assets needed to run a profitable business. In contrast, wealthier individuals do not face the same trade-offs because they can self-insure by running down their assets while searching for a job. Consequently, wealthy individuals only become self-employed if they can generate high earnings by doing so. The same pattern arises for employed individuals, who trade off their current income against the potential income from operating their own business.

Our model captures non-targeted patterns of self-employment selection and behavior. It matches the U-shaped profile of self-employment rates across the earnings

[1] Meager (2019) shows there is little heterogeneity in the micro effects of credit expansions in different countries despite significant heterogeneity in loan terms.

distribution (see Figure 1), as well as transition rates across occupations and the income auto-correlation of occupation switchers in Mexico. Further, the model matches the micro level responses of individual earnings to micro-credit supply expansions Angelucci et al. (2015) and response of wages and employment to well-identified labor demand shocks estimated in cross-sectional studies (Breza et al., 2021; Muralidharan et al., 2017), which we reproduce. As Breza et al. (2021) show, the response of wages to labor demand shocks is informative about the underlying slack in the market. As we discussed above, the low response of wages to labor demand shocks implies that there is not much dampening or amplification coming from general equilibrium effects in the labor market. In our setting, this implies that the cross-sectional effects of credit supply expansions closely aggregate-up.

**Related literature**

Our work is related to a long-standing strand of literature linking productivity and misallocation to entrepreneurship and self-employment (e.g., Hsieh and Klenow, 2009, 2014; Banerjee and Moll, 2010; Restuccia and Rogerson, 2013; Midrigan and Xu, 2014; Buera, Kaboski, and Shin, 2015). We contribute by showing the conceptual and quantitative importance of *subsistence* concerns behind self-employment in driving macroeconomic aggregates and responses to economic policy.[2]

We focus on the aggregate impact of development policies in environments where subsistence entrepreneurship is prevalent. In this sense, our work complements that of Buera, Kaboski, and Shin (2020), who highlight the importance of general equilibrium channels and longer time horizons to evaluate the macroeconomic effects of credit expansions. Similar to Buera et al. (2020), we build on the evidence from the evaluation of policy interventions through RCTs to validate the model's performance. We also show how cross-sectional moments, like the prevalence of self-employment along the earnings distribution and the response of wages to labor demand shocks, can be used to validate the model's mechanisms.

Selection into self-employment is at the core of our mechanism. Heathcote, Storesletten, and Violante (2008) study the welfare effects of insurance and risk, while Hombert, Schoar, Sraer, and Thesmar (2020, 2016), Garcia-Cabo and Madera (2019), and Levine and Rubinstein (2018) discuss the role of risk and ability on selection into entrepreneurship and self-employment. We contribute by evaluating the relevance of these margins in influencing the aggregate economy and the response to economic

[2] In related studies, Quadrini (2000) and Cagetti and De Nardi (2006, 2009) quantify the extent to which financial frictions distort the scale of firms.

policy when agents face subsistence concerns.

The introduction of unemployment risk is key to generating the subsistence concerns that lead unproductive agents to engage in self-employment. More broadly, Poschke (2019) and Feng, Lagakos, and Rauch (2020) show how labor market frictions are vital to explain cross-country differences in the workforce's composition. We show that these frictions not only lead to higher self-employment rates in developing countries but also explain the joint distribution of income and occupations that in turn shape the aggregate response to policy. Unemployed individuals are more likely to become self-employed and start smaller and potentially less productive firms as in Galindo da Fonseca (2021).

Finally, our paper adds to a large literature that studies the efficiency of social programs in developing countries where informality is high (Meghir, Narita, and Robin, 2015). Our results indicating that unemployment benefits increase aggregate productivity align with the positive effects of unemployment benefits extensions found by Gerard and Gonzaga (2021) and Britto (2020) and the work of Acemoglu and Shimer (1999, 2000).

# 1 Model

In this section we describe a quantitative model with occupational choices in which agents face unemployment risk and financial frictions. Consider a small open economy with a continuum of agents facing an international interest rate $r^{\star}$. Time is continuous and goes on forever. Agents are heterogeneous with respect to their productivity $(z)$, their asset holdings $(a)$, and their occupations. Idiosyncratic productivity is the only exogenous state, and it follows a Poisson process with arrival rate $\gamma^{z}$. Upon arrival, the agent draws a new value for $z$ from a conditional probability distribution $\Pr^{z}(z'|z)$.

There are three occupations: employment $(E)$, unemployment $(U)$, and self-employment $(S)$. The occupations differ on whether agents can freely opt into them. Agents can become unemployed or self-employed at will. In contrast, transitions to employment are governed by exogenous processes that capture, in a reduced form, the arrival of job offers to unemployed and self-employed agents. Agents are free to reject job offers and keep their current occupations. Formally, job offers follow Poisson processes with arrival rates $\gamma^{U}$ for the unemployed and $\gamma^{S}$ for the self-employed. Finally, employed agents are subject to job destruction shocks that force them into unemployment. These shocks also follow a Poisson process with arrival rate $\gamma^E$.[3]

Agents have limited access to credit markets. Employed and unemployed agents face a borrowing limit $\underline{a} \leq 0$. Self-employed agents can borrow capital for production, but they face a collateral constraint as a function on their assets: $k \leq \lambda a$. This constraint captures information frictions and commitment problems. See Cagetti and De Nardi (2006) and Buera, Kaboski, and Shin (2011), among others, for microfoundations.

## 1.1 The agents' problem by occupation

**Employment.** Agents receive an income of $w\epsilon(z)$ while employed, where $w$ is the aggregate wage rate and $\epsilon(z)$ are the agent's effective units of labor, which are a function of their productivity. In practice, we assume that $\epsilon(z) = z^\eta$, where $\eta$ captures the relevance of productivity for the earnings of employed workers.[4] Employed agents are subject to job destruction shocks with arrival rate $\gamma^E$ that force them into unemployment and productivity shocks that arrive at rate $\gamma^z$. The value of an employed agent is the solution to the following Hamilton-Jacobi-Bellman (HJB) equation:

$$\begin{aligned} \rho V^E(a,z) &= \max_c u(c) + V_a^E(a,z)\,\dot{a} + \gamma^E\left(V^U(a,z) - V^E(a,z)\right) \\ &\quad + \gamma^z \int \left(V^E(a,z') - V^E(a,z)\right) d\mathrm{Pr}^z(z'|z) \\ \text{s.t.} &\quad \dot{a} = w\epsilon(z) + ra - c, \qquad a \geq \underline{a}. \end{aligned} \tag{1}$$

Additionally, the value of an employed agent must satisfy

$$V^E(a,z) \geq \max\left\{V^U(a,z), V^S(a,z)\right\}, \tag{2}$$

where $V^U$ and $V^S$ are the values of unemployed and self-employed agents, respectively, which we define below in equations (3) and (6). The inequality in (2)

[3] Appendix A presents a version of the model without unemployment risk. The contrast between these models highlights the role of unemployment risk in generating subsistence self-employment.

[4] The reader might be tempted to conclude that $\mathrm{var}(\log w\epsilon(z)) = \eta^2 \mathrm{var}(\log z)$; however, this relationship does not hold due to endogenous selection in and out of employment. Moreover, having a single productivity shifter $(z)$ is a conservative assumption, as it reduces the gains from the reallocation of individuals between employment and self-employment (i.e., there are no individuals who are unproductive as self-employed but highly productive as employed). We also explored results with independent labor and entrepreneurial productivity processes, which are accessible at `https://ocamp020.github.io/HO_Self_Employment.pdf`.

captures the occupational choice of an employed agent. Because agents are free to become unemployed or self-employed at any time, the value of agents choosing to remain employed must be at least that of the alternative occupations.

**Unemployment.** Agents receive an income of $b$ and get job offers at rate $\gamma^U$ while unemployed.[5] We assume $b < \min_z \epsilon(z)$ so that employment is always preferable to unemployment. Unemployed agents also receive productivity shocks that arrive at rate $\gamma^z$. The value of an unemployed agent is the solution to the following HJB equation:

$$\begin{aligned} \rho V^U(a,z) &= \max_c u(c) + V_a^U(a,z)\,\dot{a} + \gamma^U \max\left\{V^E(a,z) - V^U(a,z), 0\right\} \\ &\quad + \gamma^z \int \left(V^U(a,z') - V^U(a,z)\right) d\mathrm{Pr}^z(z'|z) \\ \text{s.t.} &\quad \dot{a} = b + ra - c, \qquad a \geq \underline{a}. \end{aligned} \tag{3}$$

Additionally, the value of an unemployed agent must satisfy

$$V^U(a,z) \geq V^S(a,z). \tag{4}$$

The inequality in (4) captures the occupational choice of an unemployed agent. Because agents are free to become self-employed at any time, the value of agents choosing to remain unemployed must be at least that of being self-employed.

**Self-employment.** Agents engage in the production of final goods that they sell in a competitive market while self-employed. Production combines capital and (efficiency units of) labor through a technology that depends on the agent's productivity. The production technology is captured by

$$f(z,k,n) = z\left(k^\alpha n^{1-\alpha}\right)^\nu, \tag{5}$$

where $\alpha \in (0,1)$ and $\nu \leq 1$. In general, agents are prevented from operating at their optimal scale because of the collateral constraint they face. Agents' earnings come from profits $\pi(a,z)$ that depend on their assets and productivity.[6]

Self-employed agents get job offers at rate $\gamma^S$ and productivity shocks at rate $\gamma^z$. They

[5] Unemployment income $b$ can be interpreted as home production or as transfers from family members or government agencies. In Section 5 we take the latter view and examine what happens if $b$ increases.

[6] The dependence of self-employment earnings on assets implies that individual-level earnings across occupations are not perfectly correlated.

are free to reject job offers and so will only accept offers if the value of employment is higher than the value of self-employment given their current state $(a, z)$. The value of a self-employed agent is the solution to the following HJB equation:

$$\begin{aligned} \rho V^{S}(a,z) &= \max_{c}\, u(c) + V_{a}^{S}(a,z)\,\dot{a} + \gamma^{S} \max\left\{V^{E}(a,z) - V^{S}(a,z),0\right\} \\ &\quad + \gamma^{z} \int \left(V^{S}(a,z') - V^{S}(a,z)\right) d\mathrm{Pr}^{z}(z'|z) \\ \text{s.t.} \quad & \dot{a} = \pi(a,z) + ra - c, \qquad a \geq \underline{a}, \\ & \pi(a,z) = \max_{k \leq \lambda a\,,\, n \geq 0} f(z,k,n) - wn - (r+\delta)\,k\,. \end{aligned} \tag{6}$$

Finally, the value of a self-employed agent must satisfy

$$V^{S}(a,z) \geq V^{U}(a,z)\,, \tag{7}$$

which captures the occupational choice of self-employed agents in much the same way as (4) captures the choice of the unemployed.

Self-employed agents operate a common technology. Introducing a menu of technologies and installation costs, as in Midrigan and Xu (2014) or Buera, Kaboski, and Shin (2011), would only strengthen our results by making low-productivity self-employment more attractive for low-wealth agents, who would choose inferior technologies associated with low installation costs. A similar logic follows from expanding the model to allow for formal and informal technologies, akin to Meghir, Narita, and Robin (2015).

**Savings choice.** The optimal consumption/savings decision can be found in all occupations from the first-order condition of the agent's problem (see Achdou, Han, Lasry, Lions, and Moll, 2021). Letting $o \in \{E, U, S\}$ denote the occupation of the agent,

$$c^{o}(a,z) = u'^{-1}\left(V_{a}^{o}(a,z)\right). \tag{8}$$

**Occupational choice.** The agents' occupational choice implicitly defines regions $\Omega^{o}$ in the space of assets and productivity $\mathcal{S} \equiv [\underline{a}, \infty) \times \mathbb{R}_{+}$ in which each occupation $o \in \{E, U, S\}$ prevails over its alternatives. These regions are characterized by equations (2), (4), or (7), respectively, holding with strict inequalities. For employed agents,

$$\Omega^E = \left\{(a,z) \in \mathcal{S} \,|\, V^E(a,z) > V^S(a,z)\,\right\}, \tag{9}$$

for unemployed agents,

$$\Omega^U = \left\{(a,z) \in \mathcal{S} \,|\, V^U(a,z) > V^S(a,z)\,\right\}, \tag{10}$$

and for self-employed agents, $\Omega^S = \mathcal{S} \setminus \Omega^U$.

The shape of the occupational regions $\Omega^o$ plays a central role in determining the composition of self-employment, aggregate productivity, output, and wages. We show numerically in Section 3 that $\Omega^E$ and $\Omega^U$ are characterized by minimum (threshold) values of productivity required for an agent to become self-employed coming from either employment or unemployment. For employed agents, the productivity threshold decreases monotonically with assets, reflecting the fact that self-employment income increases with assets as the collateral constraint loosens. In contrast, for unemployed agents, the productivity threshold is non-monotone in assets. In fact, the minimum productivity required for self-employment tends to zero as the agent's asset holdings decrease toward $\underline{a}$. This is because unemployment becomes intolerable for poor agents who cannot self-insure using their savings. This behavior gives rise to low-productivity self-employed agents who populate the low end of the earnings distribution.

Reforms that affect the availability of credit to the self-employed or insure unemployed agents from having low consumption levels have a direct effect on the minimum productivity required for self-employment. We show in Section 4 that the occupational choices of agents with low assets are highly sensitive to the environment they face. By preventing low-productivity agents from becoming self-employed, it is possible to increase aggregate productivity and output, potentially increasing welfare.

## 1.2 Labor market

There is a competitive market for the efficiency units of labor. Only employed agents can supply labor. The supply of efficiency units of labor is

$$N^S = \int \epsilon(z) dG^E\,, \tag{11}$$

where $G^E$ is the distribution of employed agents in the economy.

The demand for labor comes from the production activities of the self-employed. Total labor demand is thus

$$N^D = \int n^\star(a,z)\, dG^S\,, \tag{12}$$

where $G^S$ is the distribution of self-employed agents in the economy and $n^\star(a,z)$ is the optimal labor demand from a self-employed agent with assets $a$ and productivity $z$.

## 1.3 Aggregate output and productivity

All output is produced by the self-employed. Thus, aggregate output in the economy is

$$Y \equiv \int z\left(k^\star(a,z)^\alpha n^\star(a,z)^{1-\alpha}\right)^\nu dG^S = Z\left(M^S\right)^{1-\nu}\left(K^\alpha N^{(1-\alpha)}\right)^\nu, \tag{13}$$

with aggregate inputs $K \equiv \int k^\star(a,z)\, dG^S$ and $N$ as in (12). $M^S \equiv \int dG^S$ is the mass of self-employed agents, which plays a role when the production technology in (5) exhibits decreasing returns to scale ($\nu < 1$).

Aggregate (average) productivity or TFP is

$$Z \equiv \left[\frac{1}{M^S}\int\left(z\cdot\frac{1}{\tilde{\tau}(a,z)}\right)^{\frac{1}{1-\nu}} dG^S\right]^{1-\nu}, \tag{14}$$

where $\tilde{\tau}$ is defined as in Hsieh and Klenow (2009) to be a firm-specific wedge that captures the extent of the distortions generated by the collateral constraint.[7] The aggregation procedure is standard and follows Hopenhayn (2014). TFP is affected by changes in the selection into self-employment via changes in the distribution $G^S$ and by changes in financial frictions faced by self-employed agents via the wedges $\tilde{\tau}$. Policies that lead more productive agents to become self-employed, increase the asset holdings of self-employed agents, or loosen collateral constraints increase productivity through their effects on $G^S$ and $\tilde{\tau}$.

## 1.4 Equilibrium

We focus on the stationary equilibrium of the economy (Appendix B describes the solution's computational implementation). A stationary equilibrium for this economy

[7] Formally, $\tilde{\tau}$ is such that $k(a,z) = \left[\left(\frac{\nu\alpha}{\tilde{\tau}(a,z)(R+\delta)}\right)^{1-\nu(1-\alpha)}\left(\frac{\nu(1-\alpha)}{w}\right)^{\nu(1-\alpha)} z\right]^{\frac{1}{1-\nu}}$ for each $(a,z)$.

is a set of value functions $\{V^o\}_{o\in\{E,U,S\}}$ along with optimal consumption functions $\{c^o\}_{o\in\{E,U,S\}}$, capital and labor demand from self-employed $\{k^\star, n^\star\}$, prices $\{r, w\}$, and a distribution of agents for each occupation $\{G^o\}_{o\in\{E,U,S\}}$ such that, given an international interest rate $r^\star$ and exogenous processes for job offers, job destruction, and productivity shocks, the following holds:

1. Value functions $\{V^o\}_{o\in\{E,U,S\}}$ solve the system of HJB variational inequalities:

$$0 = \max\left\{\rho V^E - \max_c u\left(c\right) - V_a^E \cdot \left(w\epsilon(z) + ra - c\right) - \frac{\mathbb{E}\left[dV^E\right]}{dt}\,,\, V^E - V^S\right\}, \quad (15)$$

$$0 = \max\left\{\rho V^U - \max_c u\left(c\right) - V_a^U \cdot \left(b + ra - c\right) - \frac{\mathbb{E}\left[dV^U\right]}{dt}\,,\, V^U - V^S\right\}, \quad (16)$$

$$0 = \max\left\{\rho V^S - \max_c u\left(c\right) - V_a^S \cdot \left(\pi + ra - c\right) - \frac{\mathbb{E}\left[dV^S\right]}{dt}\,,\, V^S - V^U\right\}. \quad (17)$$

   These variational inequalities capture jointly the agent's dynamic problem (equations 1, 3, and 6) and their occupational choice (equations 2, 4, and 7).
2. Consumption functions $\{c^o\}_{o\in\{E,U,S\}}$ (and thus asset accumulation) are consistent with the agent's optimization as in equation (8).
3. Capital and labor demand $\{k^\star, n^\star\}$ solve the profit-maximization problem of the self-employed:

$$\{k^\star, n^\star\} = \underset{k\leq\lambda a\,,\, n\geq 0}{\text{argmax}} \left\{z\left(k^\alpha n^{1-\alpha}\right)^\nu - wn - \left(r+\delta\right)k\right\}. \quad (18)$$

4. The interest rate $r$ is given by the international interest rate $r^\star$.
5. The wage $w$ is such that the labor market clears: $N^S = N^D$, with labor supply as in (11) and labor demand as in (12).
6. The distributions of agents for each occupation $\{G^o\}_{o\in\{E,U,S\}}$ are stationary, and their densities $\{g^o\}_{o\in\{E,U,S\}}$ solve the following system of Kolmogorov-forward

equations:

$$
\begin{aligned}
0 &= -\frac{\partial}{\partial a}\left[\dot{a} g^{E}(a,z)\right] - \left(\gamma^{E}+\gamma^{z}\right) g^{E}(a,z) && (19)\\
&\quad + \gamma^{z}\int \mathrm{Pr}^{z}\left(z|z'\right) g^{E}(a,z')\,dz' + \gamma^{U} g^{U}(a,z) + \gamma^{S} g^{S}(a,z)\,\mathbb{1}_{\{(a,z)\in\Omega^{E}\}}\\
0 &= -\frac{\partial}{\partial a}\left[\dot{a} g^{U}(a,z)\right] - \left(\gamma^{U}+\gamma^{z}\right) g^{U}(a,z) && (20)\\
&\quad + \gamma^{z}\int \mathrm{Pr}^{z}\left(z|z'\right) g^{U}(a,z')\,dz' + \gamma^{E} g^{E}(a,z),\\
0 &= -\frac{\partial}{\partial a}\left[\dot{a} g^{S}(a,z)\right] - \left(\gamma^{S}\mathbb{1}_{\{(a,z)\in\Omega^{E}\}}+\gamma^{z}\right) g^{S}(a,z) && (21)\\
&\quad + \gamma^{z}\int \mathrm{Pr}^{z}\left(z|z'\right) g^{S}(a,z')\,dz' + \gamma^{E} g^{E}(a,z)\,\mathbb{1}_{\{(a,z)\notin\Omega^{U}\}},
\end{aligned}
$$

where (19) holds for $(a,z)\in\Omega^{E}$, (20) holds for $(a,z)\in\Omega^{U}$, and (21) holds for $(a,z)\notin\Omega^{U}$. Moreover, the distributions $\{G^{o}\}_{o\in\{E,U,S\}}$ are such that $1=\int dG^{E}+\int dG^{U}+\int dG^{S}$. Thus, $\int dG^{o}$ gives the mass of agents in occupation $o\in\{E,U,S\}$.

We provide more details on the transitions of agents across occupations in Appendix B.

# 2 Model calibration

We calibrate the model in two steps. First, we calibrate a group of parameters externally, with values taken from the literature or chosen independently of the model's equilibrium outcomes. We then choose a second group of parameters to match targeted moments of the earnings distribution, workforce composition, and transition rates across occupations. We use aggregate and micro data from Mexico to calibrate the second group of parameters. These high-quality data allow us to explore the workforce composition as well as individual transitions in and out of self-employment.

The data we use to construct the targeted moments come from the *Encuesta Nacional de Ocupación y Empleo* (ENOE), a household survey administered by the National Institute of Statistics and Geography (INEGI) in Mexico.[8] The ENOE includes a rotating panel of responding households who participate in the survey for up to five quarters. We analyze data from 2005.Q1 to 2019.Q4, and we restrict our attention to

[8]See http://en.www.inegi.org.mx/proyectos/enchogares/historicas/enoe/.

men aged 23 to 65 who are heads of households and live in one of Mexico's ten largest municipalities.[9] We define as self-employed an individual who reports working in their own business. In Appendix D.1 we show the comparison of average occupational rates for our samples versus the overall Mexican population and versus the U.S. population as a benchmark.

Before discussing the parameter values, we define the parameterization of the productivity process and the discretization of assets.

**Productivity process.** We discretize the process for productivity $(z)$ so that the conditional probability distribution $\Pr^z(z'|z)$ is characterized by a stochastic matrix of dimensions $n_z \times n_z$. We use the method proposed in Rouwenhorst (1995) to discretize an AR(1) processes for $\log(z)$, which reduces the number of parameters to choose from $n_z(n_z - 1)$ to just the standard deviation and persistence of the process, $\sigma_z$ and $\rho_z$. We also set $n_z = 11$. We experimented with finer grids and verified that our results do not depend on the particular size we chose.

**Asset grid.** We use a curved grid with $n_a = 120$ nodes. Curvature ensures a higher density for low levels of assets. The grid's limits are given by the borrowing constraint $(\underline{a})$ and an asset barrier $(\overline{a})$. The asset grid is given by

$$a_i = \underline{a} + \left(\frac{i-1}{n_a - 1}\right)^{\eta_a} (\overline{a} - \underline{a}) \quad \text{for } i \in \{1, \ldots, n_a\}. \tag{22}$$

Table 1b presents the values of all computational parameters.

**Externally calibrated parameters.** The discount factor is taken from Moll (2014) to match a 5 percent annual discount rate. We set the annual interest rate at 3 percent to target an annual gap to the discount factor of 0.02 as in Itskhoki and Moll (2019). The degree of decreasing returns $(\nu)$ is taken from Midrigan and Xu (2014). The curvature of the utility function $(\sigma)$ is set to 2, and the power of capital in the production technology $(\alpha)$ is set to $0.3$, consistent with standard values used in the literature. We set the collateral constraint parameter $(\lambda)$ to match a debt-to-asset ratio of 42 percent, consistent with observed debt-to-asset ratios for large firms in Mexico, gathered from Compustat. We set the depreciation rate of capital to an annual rate of 5 percent.

[9] Our results are robust to including both men and women instead.

| | Externally Calibrated Parameters | |
|---|---|---|
| | Parameter | Value |
| $r^\star$ | International Interest Rate | 0.0075 |
| $\rho$ | Discount Factor | 0.0125 |
| $\sigma$ | CRRA Parameter | 2 |
| $\alpha$ | Technology – Capital Share | 0.3 |
| $\delta$ | Capital Depreciation | 0.0125 |
| $\nu$ | Technology – Decreasing Returns | 0.85 |
| $\lambda$ | Equity Constraint | 1.42 |
| $\gamma^\epsilon$ | Labor Efficiency – Arrival Rate | 1 |
| $\gamma^z$ | Productivity – Arrival Rate | 1 |

| | Internally Calibrated Parameters | |
|---|---|---|
| | Parameter | Value |
| $b$ | Unemployment Income | $w \cdot 10^{-5}$ |
| $\gamma^E$ | Job Destruction Arrival Rate | 0.20 |
| $\gamma^U$ | Job Offer Arrival Rate – U | 0.80 |
| $\gamma^S$ | Job Offer Arrival Rate – S | 0.50 |
| $\bar{\epsilon}$ | Labor Efficiency – Base Value | 0.10 |
| $\eta$ | Labor Efficiency – Shifter | 3.10 |
| $\bar{z}$ | Productivity – Base Value | 1.00 |
| $\sigma_z$ | Productivity – Variance | 0.12 |
| $\rho_z$ | Productivity – Persistence | 0.17 |

(a) Model Parameters

| | Parameter | Value |
|---|---|---|
| $\underline{a}$ | Borrowing Constraint | $10^{-5}$ |
| $\bar{a}$ | Asset Barrier | 200 |
| $\eta_a$ | Asset Grid Curvature | 2 |
| $n_a$ | Asset Grid Size | 120 |
| $n_\epsilon$ | Productivity Grid Size | 11 |

(b) Computational Parameters

Table 1: Parameters

Finally, we set unemployment income to $w \cdot 10^{-5}$, a positive but small value to avoid unemployed agents having zero consumption and reflect the absence of a safety net in developing countries like Mexico. Table 1a summarizes these choices.

**Internally calibrated parameters.** We jointly choose the values for six parameters, $\sigma_z$, $\rho_z$, $\gamma^U$, $\gamma^E$, $\gamma^S$, and $\eta$, to target six moments. These are the unemployment rate, the self-employment rate, the volatility of log-income for employed and self-employed agents, and the correlation of individual-level income for agents who stay employed and those who stay self-employed in consecutive quarters ($corr(y_t^o, y_{t+1}^o)$ for $o \in S, E$).

Although these six parameters affect all six moments, the $\gamma^o$ parameters are more important for mean occupational rates as they affect transitions between occupations. The remaining parameters, $\eta$, $\sigma_z$, and $\rho_z$, are more important for income moments as they affect the productivity process. Table 1a reports the values of the parameters, while Table 2 shows the value of the targeted moments in the data and the model. We match all moments closely, including income moments for the employed and self-employed, despite having a single productivity shifter.

One key result of the calibration is that the self-employed have a lower job offer arrival rate ($\gamma^S$) compared to that of the unemployed ($\gamma^U$). Lower job arrival rates from

| Occupational Rates | Data | Model |
|---|---|---|
| Unemployment | 4.4 | 4.1 |
| Self-employment | 26.7 | 26.2 |
| Employment | 69.1 | 69.7 |

| Income Moments | Data | Model |
|---|---|---|
| $\text{std}(y_t^S)$ | 0.86 | 0.86 |
| $\text{std}(y_t^E)$ | 0.54 | 0.58 |
| $\text{corr}(y_t^S, y_{t+1}^S)$ | 0.59 | 0.59 |
| $\text{corr}(y_t^E, y_{t+1}^E)$ | 0.60 | 0.58 |

Table 2: Targeted Moments

***Note:*** *The table specifies targeted moments for internally calibrated parameters. We only target two out of the three occupational rates, as together they imply the third. We report all three occupational rates for completeness.*

self-employment are consistent with cross-sectional findings by Jackson (2020), who indicate that engaging in gig-economy jobs in the U.S. reduces the rate at which individuals find salaried employment. In Appendixes D.2 and D.3, we provide a battery of reduced-form correlations documenting that individuals in Mexico who have second earners in their household or receive remittances from abroad (variables that indicate looser financial constraints) transition into self-employment less often, even when their self-reported job finding activities are similar to individuals who do not receive remittances and do not have a second earner in their household. We also document that individuals who engage in self-employment transition less into salaried work than unemployed individuals. We take this evidence as suggestive of potential negative effects of self-employment for individuals who engage in it out of necessity.

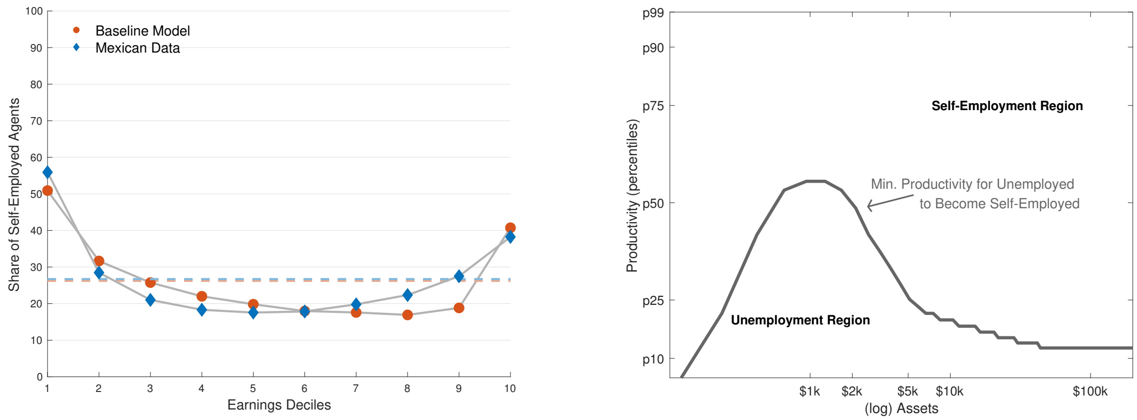
# 3 Model performance and validation

We now turn to the model's ability to match salient features of self-employment in developing economies. As mentioned above, the model can match targeted moments (Table 2). Moreover, it performs well on a wide range of non-targeted dimensions, like the prevalence of self-employment across the income distribution, the relative response of wages to employment after well-identified labor demand shocks, transition rates across occupations, and individual-level income changes after an occupation change.

**Self-employment across the income distribution.** The model matches self-employment rates across the income distribution, as in Figure 1. It produces low-earning self-employed agents in equilibrium, capturing the joint distribution of occupational rates and earnings. Figure 2a plots the self-employment rate for

Figure 2: Model Performance

(a) Self-Employment Rate by Decile of Earnings (b) Occupational Choice




***Note:*** *The left panel reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model with unemployment risk, and the blue diamonds show the data equivalent for Mexico. The right panel reports productivity thresholds characterizing the occupational choice of unemployed agents. The line depicts the threshold value of productivity* ($z$) *for each level of assets* ($a$)*. The agent chooses self-employment if her productivity is above the threshold.*

individuals in each decile of the earnings distribution, both in the data and the model.[10]

The model captures the U-shape of self-employment rates thanks to the selection into self-employment from unemployment. This mechanism is reflected in the non-monotonicity of the minimum (threshold) productivity required to become self-employed (Figure 2b). The threshold decreases for poor unemployed individuals as they become poorer, so more individuals with low productivity become self-employed.

**Response to labor demand shocks.** We next compare the responses of employment and wages to an exogenous increase in labor demand in the model and in cross-sectional data. The shocks to labor demand are identified in the data from interventions administered at the local labor market level and are therefore informative about the general equilibrium effects at the core of our mechanism, making them good evidence to validate model specifications.[11]

The empirical evidence comes from a randomized controlled intervention carried

[10]To compute the data series in Figure 2a, we first run a regression of the form $\log(earn_{i,t}) = \alpha + \gamma_t + \beta X_{i,t} + \eta_{i,t}$, where $earn_{i,t}$ corresponds to the earnings of individual $i$ at time $t$ and $X$ is a vector of individual-level controls. We rank $\hat{\eta}_{i,t}$ and classify them in bins of 2 percent of the sample and then compute the self-employment rate in each bin. The pattern we report is robust when we use raw earnings instead of controlling for observables.

[11]We implicitly assume that local interventions do not change the real interest rate in untreated regions.

out by Breza, Kaur, and Shamdasani (2021) and from the implementation of the NREGS, a national job guarantee scheme in India (Muralidharan, Niehaus, and Sukhtankar, 2017). Both studies estimate the effects of additional labor demand coming from either the researchers' intervention or the government's, offering employment at market wages. Both show that the reaction of wages is significantly smaller than the reaction of employed work. We refer to this as an *"elasticity of wage to labor demand"* caused by a labor demand shock ($^{\Delta\% w}/_{\Delta\% N^d}$) lower than one.[12]

To reproduce the response of employment and wages to an increase in labor demand, we modify the model by introducing government demand for labor $n^{gov}$ and then solve for the new market-clearing wage.[13] The total labor demand is

$$N^d = \int n^\star(a,z)dG^S + n^{gov}. \tag{23}$$

Government labor demand amounts to 11.5 percent of the baseline demand for efficiency units of labor, as in the intervention by Breza et al. (2021).

In response to an increase in labor demand by the government, the model implies a reallocation of the workforce from self-employment into both higher employment and unemployment. This response is in line with the results of Imbert and Papp (2015), Breza et al. (2021) and Muralidharan et al. (2017). As Imbert and Papp (2015) find for the NREGS, there is a strong crowding-out effect on private employment (in this case on self-employment). Private demand for labor decreases by 9.35 percent (self-employment decreases by 1.25 percentage points). However, the overall demand for labor increases (by about 2.15 percent), as does the unemployment share of the workforce (by 0.3 percentage points). These movements are qualitatively in line with the findings of Breza et al. (2021). The decrease in self-employment comes mostly from the low-productivity self-employed agents (see Figure C.1 in Appendix C).

Crucially, the increase in labor demand is not accompanied by a sizable increase in wages. The market wage (per efficiency unit of labor) increases by 0.35 percent, implying a relative elasticity of wage to labor after a labor demand shock ($^{\Delta\% w}/_{\Delta\% N^d}$) of 0.16. This result is consistent with the experimental evidence referenced above, which establishes a low response of wages relative to increases in labor demand.

[12]This is the ratio of the elasticity of wages to the shock, over the elasticity of employment to the shock.

[13]In the spirit of the experimental intervention cited above and the implementation of the NREGS program, we do not introduce taxes to finance the government's labor demand.

| Occupational Transition Rates | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Data | Model | | Data | Model | | Data | Model |
| $U \to U$ | 27.4 | 29.3 | $S \to U$ | 1.9 | 4.6 | $E \to U$ | 3.1 | 2.5 |
| $U \to S$ | 14.6 | 23.6 | $S \to S$ | 76.8 | 62.2 | $E \to S$ | 8.1 | 12.8 |
| $U \to E$ | 58.0 | 47.1 | $S \to E$ | 21.3 | 33.1 | $E \to E$ | 88.8 | 84.7 |

| Income Moments | | | | | |
|---|---|---|---|---|---|
| | Data | Model | | Data | Model |
| $\text{corr}(y_t^E, y_{t+1}^S)$ | 0.43 | 0.39 | $\text{corr}(y_t^S, y_{t+1}^E)$ | 0.43 | 0.34 |

Table 3: Untargeted Moments

***Note:*** *The table specifies untargeted moments. All transition rates are quarterly and reported in percentage points. The income moments are auto-correlations of income conditional on occupational switching in consecutive quarters.*

**Transition rates between occupations.** The model does a good job capturing the transition rates between occupations observed in the data, as shown in Table 3. We compute transition rates in the same way in the data and in the model, based on the occupation of agents at the end of each quarter. The model predicts that transition rates from unemployment to self-employment are roughly twice as common than transitions from employment to self-employment, in line with causal evidence for Canada in Galindo da Fonseca (2021).

All transitions have the right order of magnitude even though none of them were targeted directly in our calibration. However, the model does not capture all transition patterns; it overstates the transition rate from unemployment to self-employment (23 percent in the model versus 15 percent in the data). In both the data and the model, the low unemployment rate is explained by high transition rates out of unemployment, particularly into self-employment.

**Income of occupational switchers.** The model captures the (untargeted) correlation of income for switchers observed in the data. This moment is particularly relevant for the gains following a reallocation of agents across occupations. The model implies slightly lower correlations than the data despite the common productivity shifter for both occupations, which is explained by the role of assets in determining self-employment income. The income auto-correlation of individuals who switch from employment to self-employment is 0.39 versus 0.43 in the data, and the correlation of switchers from self-employment to employment is 0.34 versus 0.43 in the data (Table 3).

# 4 Credit expansions under subsistence self-employment

We show that our model can replicate the elasticity of individual earnings to credit supply coming from an RCT that increased the availability of credit to self-employed individuals in Mexico (Angelucci et al., 2015), even when we do not target these statistics directly. Then, we use the model to study the effects of the policy on macroeconomic aggregates and welfare. Our exercise provides self-employed agents access to a loan of the same size as the loans in the experimental intervention. We modify the collateral constraint of the self-employed to be

$$k \leq \lambda \cdot a + \phi, \tag{24}$$

and we set the value of $\phi$ to be consistent with the average size of loans provided by Compartamos Bank, studied in Angelucci et al. (2015), about 540 dollars per quarter.[14]

## 4.1 Micro effects of increases in credit availability

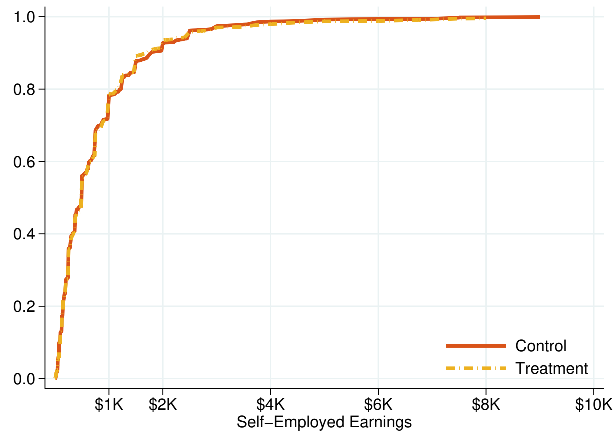
The program induces an increase in credit of 20 percent (including funds from the program and private sources). This results in small changes in the distribution of individual-level earnings of the self-employed in the model, with average earnings increasing 0.95 percent. This implies an elasticity of self-employment income to lending of 0.0475.

The average change in self-employment profits is roughly 8 dollars and the change in business revenue is 41 dollars per quarter in general equilibrium, where we allow for adjustment in wages in local economies. In the data, the increase in self-employment profits on the local areas where credit supply was expanded was zero and the increase in business revenue is equal to 55 dollars per quarter.[15] To provide context, Figure 3 shows the cumulative density function (CDF) of self-employment earnings in treated and control local economies in Angelucci et al. (2015). The two CDFs are close throughout the support, meaning that the earnings gains of self-employed individuals caused by an expansion of credit access are small for both poor and rich individuals.

[14] This policy is qualitatively different form a reduction in financial frictions as captured by an increase in $\lambda$. Even though both changes loosen the financial constraint, they do so in different ways for poor agents. We explore the consequences of financial reforms that increase $\lambda$ in Appendix C.2.

[15] To reach this number we multiply the effect of 121 pesos every two weeks reported in Angelucci et al. (2015), times 6 to get quarterly numbers, bring 2009 pesos to 2019 using the Mexican CPI, and use the average nominal exchange rate between the Mexican Peso and the US Dollar 19.24 for 2019.

Figure 3: Change in Self-Employment Earnings in Angelucci et al. (2015)



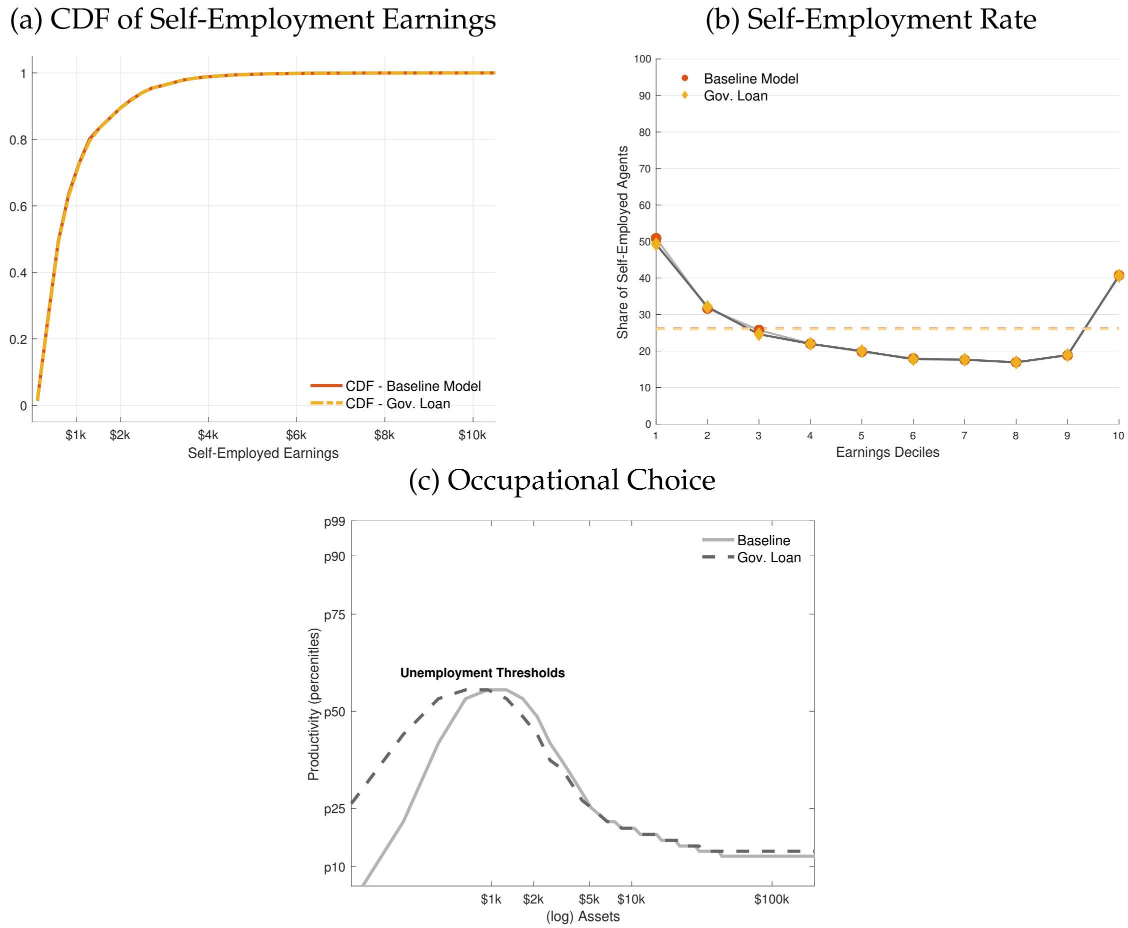

***Note:*** *The figure reports the CDF of self-employment earnings for the control (red) and treatment (yellow) groups of the randomized control trial studied in Angelucci et al. (2015).*

Figure 4a shows the model analogue to Figure 3, leading to the same conclusions.

Furthermore, the model predicts small changes in the self-employment rate across the income distribution (Figure 4b) and small changes in selection into self-employment (Figure 4c). These results also hold in partial equilibrium, where wages do not adjust, see Appendix Figure C.4. The reason is that, in the model, wage adjustment is small in response to shocks that shift labor demand in the presence of slack in the labor market, in line with evidence from Breza et al. (2021) and the results in Section 3. The changes in selection are concentrated among poor individuals, raising the productivity threshold at which they engage in self-employment. We will return to these result shortly when we discuss the aggregate effects of the increase in credit availability.

The response of consumption is small, increasing just 0.02 percent on average, consistent with the small response of wages and self-employment earnings. See Table 4. Our results are also consistent with Meager (2019), who finds that after an extension of microcredit, "the impact on household business and consumption variables is unlikely to be transformative and may be negligible" in a meta study of RCTs from seven different countries, and with outcomes reported by Angelucci et al. (2015) on employment income, and several categories of non-durable consumption.

Figure 4: Model Response to Increase in Credit




***Note:*** *Panel (a) reports the CDF of self-employment earnings in the model. The continuous red line corresponds to the baseline model, and the dashed yellow line corresponds to the model with expanded credit access in general equilibrium. Panel (b) reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model, and the yellow squares correspond to the model with expanded credit access in general equilibrium. Panel (c) reports productivity thresholds characterizing the occupational choice of unemployed agents for the baseline model (continuous light gray line) and the model with credit deepening (dashed dark gray line). Lines depict the threshold value of productivity $(z)$ for each level of assets $(a)$. The agent chooses self-employment if productivity is above the threshold.*

## 4.2 Macro effects of increases in credit availability

We now turn to the aggregate effects of the increase in credit availability. Table 4 summarizes the results. Output increases by 0.2 percent, driven by changes in composition among the self-employed and increases in their production scale. This implies an elasticity of aggregate output to lending of 0.011. Importantly, the low elasticity of wages (that increase only 0.06 percent) implies that the general equilibrium response to the intervention is muted. Therefore, the individual effects on the

| Variable | Δ | Variable | %Δ | Variable | %Δ |
|---|---|---|---|---|---|
| Employment | 0.08 | TFP | 0.15 | % Output | 0.20 |
| Unemployment | 0.16 | Income(E) | 0.04 | Consumption | 0.02 |
| Self-Employment | −0.24 | Income(SE) | 0.95 | Assets | −0.40 |

Table 4: Model Response to Increase in Credit

***Note:*** *The table presents changes in variables with respect to the baseline model after access to credit was expanded. All numbers are in percentage points.*

self-employed aggregate. Specifically, the elasticity of output with respect to lending is proportional to the elasticity of self-employment earnings (0.0475) times their share in the population (26 percent).[16]

The differential effect of the policy on the occupational choice of low- and high-productivity agents generates a change in the selection into self-employment, which plays a key role in shaping the aggregate effects of the policy. In the aggregate, there is a reallocation away from self-employment, although this effect is small.[17] More credit supply could in principle lead to higher self-employment rates as more individuals may decide to start businesses. However, only the more productive agents can successfully take advantage of the new funds. In fact, there is a reallocation of capital and labor into the hands of more productive agents. The increase in labor demand from more productive self-employed individuals generates a small increase in wages, which reduces the profitability of low-productivity self-employment, in turn triggering the reallocation away from self-employment.

There is an increase of TFP that drives three fourths of the increase in output as a result of the differential effects of the policy in favor of high productivity self-employed individuals. Both the change in the composition of the self-employed (skewed toward more productive agents) and the loosening of their collateral constraints result in higher aggregate productivity. TFP increases by 0.15 percent, which amounts to an elasticity of TFP to lending of 0.008. These results highlight the importance of the aggregation exercise, showing that the micro effects of the policy aggregate up, leading to positive macro effects in output and productivity.

Finally, we find that the expansion of credit availability has positive welfare effects.

[16] The same argument applies to the change in output (0.2 percent), which is proportional to the change in self-employment earnings (0.95 percent) times their share of the population.

[17] This effect is consistent with the findings of Angelucci et al. (2015) who report a negative but insignificant point estimate for the share of individuals who have a business.

We measure welfare in consumption equivalent units, defined as the percentage increase in consumption that would make an agent indifferent between our baseline economy (B) and the economy where the policy has been implemented (P). Formally, the consumption equivalent welfare measure for an agent in occupation $o$ with $a$ assets and a productivity of $z$ is characterized by.

$$1 + \mathrm{CE}^{o}(a, z) = \left( \frac{V_P^o(a, z)}{V_B^o(a, z)} \right)^{\frac{1}{1-\sigma}} . \tag{25}$$

The average welfare change in the economy is 0.07 percent. Gains are broad based and are only slightly higher among the unemployed, who gain the equivalent of 0.13 percent of lifetime consumption, on average.

# 5 Micro and macro effects of policy design

We now use the model to study how differences in the targeting or design of policies affect their aggregate results. We first vary the policy's design by subsidizing the interest rate charged for the loans, then we replace loans for transfers targeted to the unemployed or the non-employed. We find that all these variations in policy design generate very similar and small effects at the micro level (i.e. changes in individual earnings). However, the aggregate effects vary starkly across designs. Subsidized loans and transfers to the non-employed generate sizable productivity losses, while transfers to the unemployed generate productivity gains.

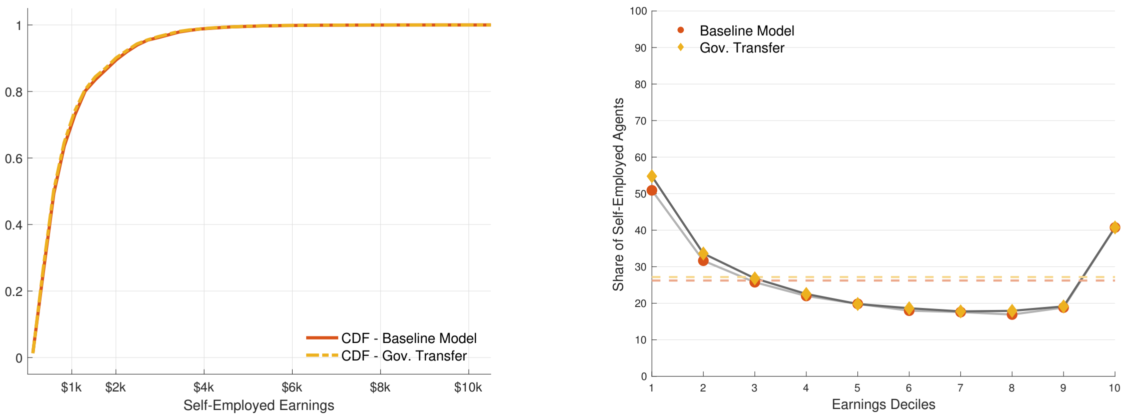
**Subsidized loans to the self-employed.** We increase the availability of credit by the same magnitude as in Section 4, but increase the program's generosity by fully subsidizing the loans' interest rate. We do this in the spirit of Meager (2019), who reports wide variation in the generosity of loan terms across microfinance programs.

The effects of introducing zero-interest loans on individual self-employed earnings are small, similar to those of regular loans explored above. Figure 5 shows the CDF of self-employment earnings and the joint distribution of income and occupations in our baseline economy and the economy with the expansion in zero-interest loans. In both cases the distributions are close together regardless of treatment status, consistent with the results in Meager (2019). However, Figure 5b shows that there is a larger response in the composition of the self-employed, with more low-earning self-employed after the

Figure 5: Model Response to Introduction of Zero-Interest Loans

(a) CDF of Self-Employment Earnings

(b) Self-Employment Rate




***Note:*** *Panel (a) reports the CDF of self-employment earnings in the model. The continuous red line corresponds to the baseline model, and the dashed yellow line corresponds to the model with zero-interest loans in general equilibrium. Panel (b) reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model, and the yellow squares correspond to the model with zero-interest loans in general equilibrium.*

introduction of the policy. This contrasts with Figure 4b that did no show meaningful changes in the joint distribution of self-employment and earnings.

The aggregate effects of the subsidized loans on average self-employment earnings, participation, and TFP go in the opposite direction as the ones described in Section 4. Subsidized loans increase the self-employment rate, and TFP decreases by almost half a percentage point. The average self-employment income decreases by 2.4 percent, while the income of those with wage employment increases by 0.5 percent, driven by an increase of 0.72 percent in the wage.

The difference between the effects of the two policies resides in the compositional changes subsidized loans trigger.

The decline in TFP is triggered by changes in occupational choices that generate an

| Variable | $\Delta$ | Variable | $\%\Delta$ | Variable | $\%\Delta$ |
|---|---|---|---|---|---|
| Employment | $-0.24$ | TFP | $-0.45$ | % Output | 0.24 |
| Unemployment | $-0.72$ | Income(E) | 0.50 | Consumption | 0.15 |
| Self-Employment | 0.96 | Income(SE) | $-2.40$ | Assets | $-1.11$ |

Table 5: Model Response to Introduction of Zero-Interest Loans

***Note:*** *The table presents changes in variables with respect to the baseline model after the introduction of zero-interest loans. All numbers are in percentage points.*

inflow of low-productivity self-employed individuals. Unlike interest-bearing loans, subsidized loans are particularly advantageous to low-productivity self-employed individuals who have low rates of return. As a result, more low-productivity agents choose to become self-employed, reducing aggregate productivity.

Although TFP decreases, output increases 0.24 percent, which is due to two forces that counteract the decline in productivity. First, the availability of cheap credit increases the overall amount of capital used for production. Second, a higher self-employment rate increases measured output because of the decreasing returns to scale at the micro level (see 13). Welfare also increases by 0.68 percent on average. This comes as no surprise given the higher generosity and higher take-up of subsidized loans.

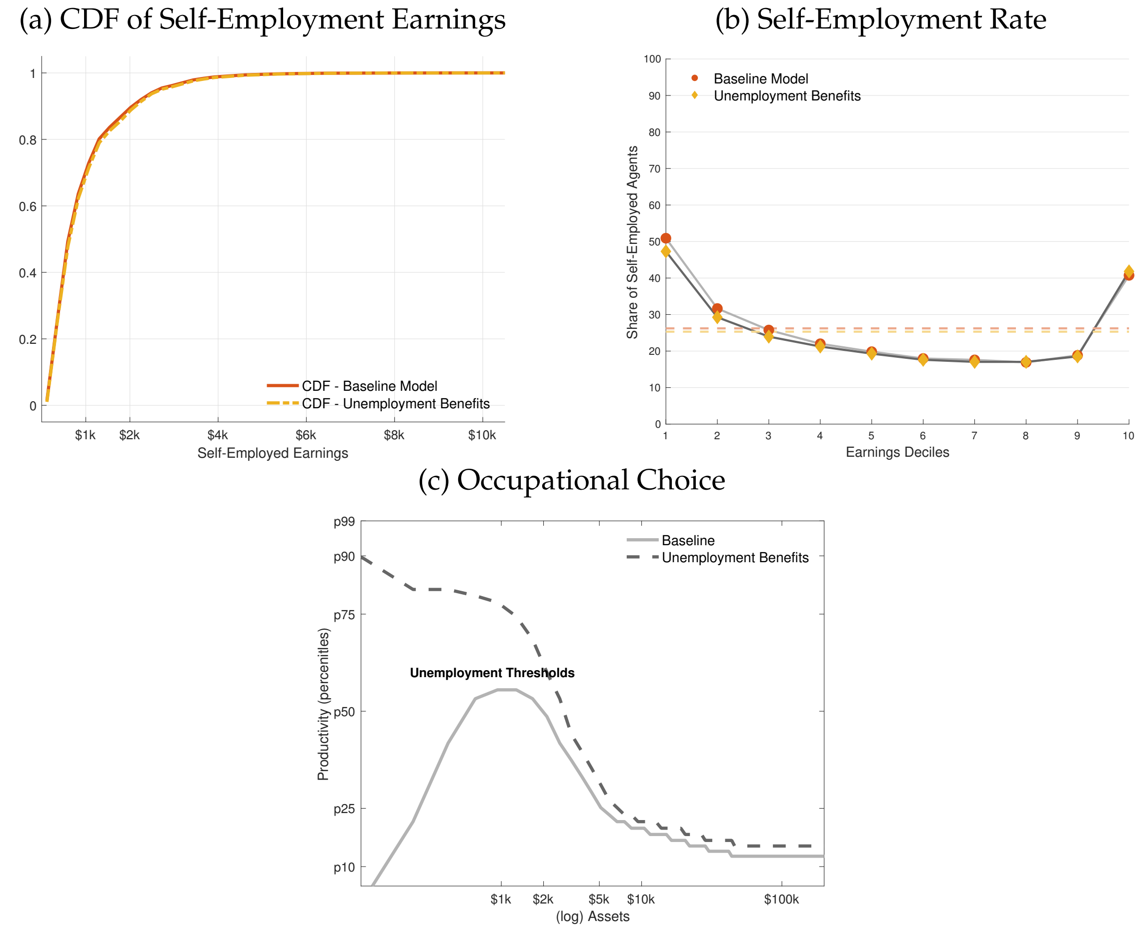
This exercise shows how changes in the policy design can substantially change the policy's aggregate effects. The key driver of these differences is the endogenous occupational choice of agents. When driven by subsistence concerns, agents respond even to small incentives, leading to changes in the aggregate effects of policies.

**Direct transfers.** We now explore the implications of targeted transfer policies, which are often used in developing economies (Banerjee et al., 2019). The key mechanism of the model is the endogenous response of occupational choices to changes in outside options and the relationship of these choices with production. For that reason, we study policies that directly alter these margins by targeting transfers to the unemployed and, alternatively, to those who are not employed. In Appendix C.4 we also consider a broader policy providing means-tested transfers to the entire population.

We first introduce a policy that gives transfers to unemployed agents, raising their income to $b + \tilde{b}$. We set $\tilde{b}$ to 18 dollars, about 10 percent of the lowest wage among the employed in the model. The benefits do not expire and are financed via labor income taxes.

Figure 6b shows a small impact among low-earning individuals for whom the self-employment rate drops slightly. This drop is due to the change in the occupational choices of poor unemployed agents. The transfer effectively provides insurance for poor individuals, preventing those with low productivity from entering self-employment. Figure 6c makes this clear by showing the change in the productivity threshold characterizing the unemployed agents' occupational choice—the minimum productivity level at which they become self-employed. This change in selection plays a central role in explaining the policy's aggregate effects.

Figure 6: Model Response to Transfers to the Unemployed




***Note:*** *Panel (a) reports the CDF of self-employment earnings in the baseline model (solid red line) and the model with transfers to the unemployed (dashed yellow line). Panel (b) reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model, and the yellow squares correspond to the model with transfers to the unemployed in general equilibrium. Panel (c) reports productivity thresholds characterizing the occupational choice of unemployed agents for the baseline model (continuous light gray line) and the model with credit deepening (dashed dark gray line). Lines depict the threshold value of productivity* $(z)$ *for each level of assets* $(a)$*. The agent chooses self-employment if productivity is above the threshold.*

Aggregate productivity increases by 0.42 percent and output by 0.25 percent (see Table 6), with the total increase in output being 2.6 times the transfer cost. These gains are significant given the transfer's magnitude and are due to better selection into self-employment highlighted above. Even though the decrease of 0.9 percentage points in self-employment drives output down (see equation 13), the increase in productivity more than compensates for it. These effects are accentuated by the change in the wage rate, which decreases slightly (-0.16 percentage points) to clear the labor market. Lower wages increase entrepreneurial income but do so disproportionately for the most productive agents, increasing their scale.

| Variable | $\Delta$ | Variable | $\%\Delta$ | Variable | $\%\Delta$ |
|---|---|---|---|---|---|
| Employment | 0.06 | TFP | 0.42 | % Output | 0.25 |
| Unemployment | 0.85 | Income(E) | $-0.40$ | Consumption | $-0.26$ |
| Self-Employment | $-0.90$ | Income(SE) | 3.70 | Assets | $-0.52$ |

Table 6: Model Response to Transfers to the Unemployed

***Note:*** *The table presents changes in variables with respect to the baseline model after the introduction of transfers to the unemployed. All numbers are in percentage points.*

These results highlight how safety net programs can play a role in increasing productivity in developing countries by affecting individuals' occupation choices. These programs not only allow individuals to search for jobs longer (Acemoglu and Shimer, 1999, 2000; Chetty, 2008), but they also prevent unproductive agents from engaging in entrepreneurial activities for which they are ill-suited. This in an additional rationale for these programs, beyond insurance against income fluctuations.[18]

The gains from the transfers depend on their targeting. So far, we have assumed that the institution in charge of implementing the transfers can distinguish people's occupation. This is admittedly a stark assumption because there would be no incentives for the self-employed to reveal their status and there may be limited institutional capacity for screening. Accordingly, we consider an alternative policy in which the transfers go to every non-employed, effectively assuming no screening capacities. We provide details in Appendix C.3.

When transfers cannot be targeted exclusively to the unemployed, the aggregate effects flip sign (Tables 6 and C.1). Self-employment rates increase by 0.36 percentage points and productivity decreases by 0.32 percent. These effects are even stronger if transfers are expanded to cover all poor individuals irrespective of occupation (Appendix C.4). The reason is twofold. First, the transfer lowers selection into self-employment as low-productivity individuals take the transfer and engage in self-employment at the same time. Second, there is a strong disincentive to save, tightening the self-employed collateral constraints. Assets decrease 1.9 percent when the transfers are available to the self-employed and decrease even more when transfers are available to all individuals regardless of occupation. In this way, changes in policy implementation can do away with the desired effects, just as in the expansions of credit studied above.

[18] Providing insurance against production risk may also improve productivity by spurring entrepreneurship. See Robinson (2020) and Hombert, Schoar, Sraer, and Thesmar (2020, 2016).

# 6 Concluding remarks

Self-employment can reflect entrepreneurial drive, leading to innovation and growth. But it can also reflect subsistence concerns of individuals looking for an income source when no alternatives are available. This is painfully evident across developing economies characterized by high self-employment rates concentrated among the poor.

We show that the features of self-employment in developing economies are consistent with its role as self-insurance for poor individuals. Consequently, policies that supplement this insurance role, like providing unemployment income, are effective at preventing low-productivity individuals from becoming self-employed. This change in individual's occupational choices can increase in productivity and employment. On the contrary, policies aiming to promote entrepreneurship can have unintended consequences by making self-employment more attractive for low-productivity individuals, resulting in lower aggregate productivity. The challenging material conditions of the poor mean that even small incentives have a large impact on their occupational choices.

Incorporating labor market frictions alongside financial frictions is critical to correctly capture the aggregate dynamics of developing economies and their responses to policy. Doing so not only improves the fit of models to salient features of developing economies but also brings macro development models in line with micro estimates of the identified response of the economy to shocks (e.g., the response of wages to labor demand shocks). The key mechanism lies in incorporating the view that subsistence concerns dominate selection into self-employment among the poor.

# References

Acemoglu, D. and R. Shimer (1999). Efficient unemployment insurance. *Journal of Political Economy 107*(5), 893–928.

Acemoglu, D. and R. Shimer (2000). Productivity gains from unemployment insurance. *European Economic Review 44*(7), 1195 – 1224.

Achdou, Y., J. Han, J.-M. Lasry, P.-L. Lions, and B. Moll (2021, 04). Income and Wealth Distribution in Macroeconomics: A Continuous-Time Approach. *The Review of Economic Studies 0*(0), 1–42. rdab002.

Angelucci, M., D. Karlan, and J. Zinman (2015, January). Microcredit impacts: Evidence from a randomized microcredit program placement experiment by compartamos banco. *American Economic Journal: Applied Economics 7*(1), 151–82.

Banerjee, A. and E. Duflo (2011). *Poor economics: A radical rethinking of the way to fight global poverty*. Public Affairs.

Banerjee, A., P. Niehaus, and T. Suri (2019). Universal basic income in the developing world. *Annual Review of Economics 11*(1), 959–983.

Banerjee, A. V. and B. Moll (2010, January). Why does misallocation persist? *American Economic Journal: Macroeconomics 2*(1), 189–206.

Bianchi, M. and M. Bobba (2013). Liquidity, risk, and occupational choices. *Review of Economic Studies 80*(2), 491–511.

Breza, E., S. Kaur, and Y. Shamdasani (2021, October). Labor rationing. *American Economic Review 111*(10), 3184–3224.

Britto, D. G. C. (2020, 08). The Employment Effects of Lump-Sum and Contingent Job Insurance Policies: Evidence from Brazil. *The Review of Economics and Statistics 0*(0), 1–45.

Buera, F. J., J. P. Kaboski, and Y. Shin (2011, August). Finance and development: A tale of two sectors. *American Economic Review 101*(5), 1964–2002.

Buera, F. J., J. P. Kaboski, and Y. Shin (2015). Entrepreneurship and financial frictions: A macrodevelopment perspective. *Annual Review of Economics 7*(1), 409–436.

Buera, F. J., J. P. Kaboski, and Y. Shin (2020, 08). The Macroeconomics of Microfinance. *The Review of Economic Studies 88*(1), 126–161.

Cagetti, M. and M. De Nardi (2006). Entrepreneurship, frictions, and wealth. *Journal of Political Economy 114*(5), 835–870.

Cagetti, M. and M. De Nardi (2009, March). Estate taxation, entrepreneurship, and wealth. *American Economic Review 99*(1), 85–111.

Chetty, R. (2008). Moral hazard versus liquidity and optimal unemployment insurance. *Journal of Political Economy 116*(2), 173–234.

Daruich, D. and R. Fernandez (2021, June). Universal basic income: A dynamic assessment. Working Paper 27351, National Bureau of Economic Research.

Feng, Y., D. Lagakos, and J. E. Rauch (2020, October). Unemployment and development. Working Paper 25171, National Bureau of Economic Research.

Galindo da Fonseca, J. (2021). Unemployment, entrepreneurship and firm outcomes. *Review of Economic Dynamics*.

Garcia-Cabo, J. and R. Madera (2019). The self-employment option in rigid labor markets: An empirical investigation. International Finance Discussion Papers 164, Board of Governors of the Federal Reserve System.

Gerard, F. and G. Gonzaga (2021, August). Informal labor and the efficiency cost of social programs: Evidence from unemployment insurance in brazil. *American Economic Journal: Economic Policy 13*(3), 167–206.

Gollin, D. (2008). Nobody's business but my own: Self-employment and small enterprise in economic development. *Journal of Monetary Economics 55*(2), 219–233.

Heathcote, J., K. Storesletten, and G. L. Violante (2008). Insurance and opportunities: A welfare analysis of labor market risk. *Journal of Monetary Economics 55*(3), 501–525.

Hombert, J., A. Schoar, D. Sraer, and D. Thesmar (2016, August). Does unemployment insurance change the selection into entrepreneurship? In J. Haltiwanger, E. Hurst, J. Miranda, and A. Schoar (Eds.), *Measuring Entrepreneurial Businesses: Current Knowledge and Challenges*, NBER Book Series: Studies in Income and Wealth, Chapter 8, pp. 351–369. University of Chicago Press.

Hombert, J., A. Schoar, D. Sraer, and D. Thesmar (2020). Can unemployment insurance spur entrepreneurial activity? Evidence from France. *The Journal of Finance 75*(3), 1247–1285.

Hopenhayn, H. A. (2014). Firms, misallocation, and aggregate productivity: A review. *Annual Review of Economics 6*(1), 735–770.

Hsieh, C.-T. and P. J. Klenow (2009). Misallocation and Manufacturing TFP in China and India. *The Quarterly Journal of Economics 124*(4), 1403.

Hsieh, C.-T. and P. J. Klenow (2014). The Life Cycle of Plants in India and Mexico. *The Quarterly Journal of Economics 129*(3), 1035.

Hurst, E. G. and B. W. Pugsley (2016, October). Wealth, Tastes, and Entrepreneurial Choice. In J. Haltiwanger, E. Hurst, J. Miranda, and A. Schoar (Eds.), *Measuring Entrepreneurial Businesses: Current Knowledge and Challenges*, NBER Book Series: Studies in Income and Wealth, Chapter 3, pp. 111–151. University of Chicago Press.

Imbert, C. and J. Papp (2015, April). Labor market effects of social programs: Evidence from india's employment guarantee. *American Economic Journal: Applied Economics 7*(2), 233–63.

Itskhoki, O. and B. Moll (2019). Optimal development policies with financial frictions. *Econometrica 87*(1), 139–173.

Jackson, E. (2020). Availability of the gig economy and long run labor supply effects for the unemployed. Job Market Paper.

Katz, L. F. and A. B. Krueger (2017, May). The role of unemployment in the rise in alternative work arrangements. *American Economic Review 107*(5), 388–92.

Levine, R. and Y. Rubinstein (2018, December). Selection into entrepreneurship and self-employment. Working Paper 25350, National Bureau of Economic Research.

Meager, R. (2019, January). Understanding the average impact of microcredit expansions: A bayesian hierarchical analysis of seven randomized experiments. *American Economic Journal: Applied Economics 11*(1), 57–91.

Meghir, C., R. Narita, and J.-M. Robin (2015). Wages and informality in developing countries. *American Economic Review 105*(4), 1509–46.

Midrigan, V. and D. Y. Xu (2014, February). Finance and misallocation: Evidence from plant-level data. *American Economic Review 104*(2), 422–58.

Moll, B. (2014, October). Productivity losses from financial frictions: Can self-financing undo capital misallocation? *American Economic Review 104*(10), 3186–3221.

Muralidharan, K., P. Niehaus, and S. Sukhtankar (2017, September). General equilibrium effects of (improving) public employment programs: Experimental evidence from India. Working Paper 23838, National Bureau of Economic Research.

Poschke, M. (2013a). Entrepreneurs out of necessity: A snapshot. *Applied Economics Letters 20*(7), 658–663.

Poschke, M. (2013b). Who becomes an entrepreneur? Labor market prospects and occupational choice. *Journal of Economic Dynamics and Control 37*(3), 693 – 710.

Poschke, M. (2019). Wage employment, unemployment and self-employment across countries. Discussion Paper Series 12367, IZA - Institute of Labor Economics.

Quadrini, V. (2000). Entrepreneurship, saving, and social mobility. *Review of Economic Dynamics 3*(1), 1 – 40.

Restuccia, D. and R. Rogerson (2013). Misallocation and productivity. *Review of Economic Dynamics 16*(1), 1 – 10. Special issue: Misallocation and Productivity.

Robinson, B. (2020). Risky business: The choice of entrepreneurial risk under incomplete markets. Job Market Paper.

Rouwenhorst, K. G. (1995). Asset pricing implications of equilibrium business cycle models. In T. Cooley (Ed.), *Frontiers of Business Cycle Research*, Chapter 10, pp. 394–330. Princeton University Press.

Schoar, A. (2010). The divide between subsistence and transformational entrepreneurship. *Innovation Policy and the Economy 10*, 57–81.

# Appendices for Online Publication

## Table of Contents

# A Model without unemployment risk

In this section we describe a simplified model without unemployment risk. We lay out the model in general terms allowing for a labor efficiency component independent ($\epsilon$) of the agent's productivity ($z$). In the calibration we set the variance of $\epsilon$ to zero for comparability with our baseline model, results with both sources of variation are available upon request. As before, an agent is free to become self-employed at any point, but now the agent is also free to become employed in response to changes in her labor efficiency, productivity or assets. There is no change in the profit maximization problem of the self-employed, or in the definition of total supply and demand for labor.

## A.1 Agent's problem

Because agents can change instantly across occupations, the occupational choice problem reduces to maximizing instantaneous income. The value of an agent is then:

$$\begin{aligned} \rho V(a,z,\epsilon) = \max_{c} \; & u(c) + V_a(a,z,\epsilon)\,\dot{a} + \\ & \gamma^{\epsilon}\int V(a,z,\epsilon')\,d\mathrm{Pr}^{\epsilon}(\epsilon'|\epsilon) + \gamma^{z}\int V(a,z',\epsilon)\,d\mathrm{Pr}^{z}(z'|z) \\ & \text{s.t. } \dot{a} = \max\{w\varepsilon(\epsilon,z), \pi(a,z)\} + ra - c \qquad a \geq \underline{a} \end{aligned} \tag{A.1}$$

with $\pi(a,z)$ given as in equation (18), and $\varepsilon(\epsilon,z) = \epsilon + \eta z$.

The optimal consumption decision is found as in Section 1, following equation (8). Finally agents are employed if $w\varepsilon(\epsilon,z) \geq \pi(a,z)$ and as self-employed otherwise.

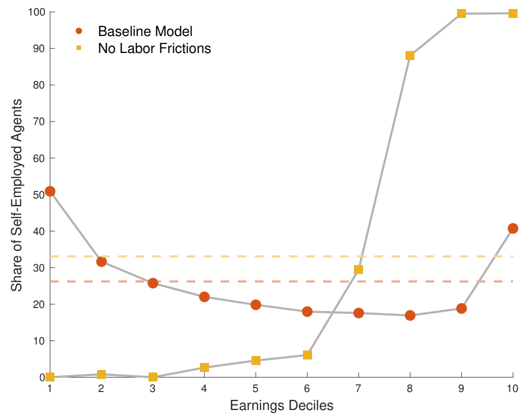
## A.2 Equilibrium

An stationary equilibrium for this economy is a value function $\{V\}$, along with an optimal consumption function $\{c\}$, labor and capital demand from self-employed $\{n,k\}$, prices $\{r,w\}$ and a distribution of agents $\{G\}$ such that:

1. The value function satisfies (A.1).
2. Consumption and asset accumulation are given by equation (8).
3. Capital and labor demand solve the self-employed's profit maximization problem.
4. Labor market clears: $N^S = N^D$, satisfying equations (11) and (12).
5. The interest rate is given by the international interest rate $r^{\star}$.
6. The distribution of agents is stationary and solves:

$$\begin{aligned} 0 = & -\frac{\partial}{\partial a}\left[\dot{a}g(a,z,\epsilon)\right] - \gamma^{z}\int \mathrm{Pr}^{z}(z'|z)\,g(a,z,\epsilon)\,dz' + \gamma^{z}\int \mathrm{Pr}^{z}\left(z|z'\right)g(a,z',\epsilon)\,dz' \\ & - \gamma^{\epsilon}\int \mathrm{Pr}^{\epsilon}(\epsilon'|\epsilon)\,g(a,z,\epsilon)\,d\epsilon' + \gamma^{\epsilon}\int \mathrm{Pr}^{\epsilon}\left(\epsilon|\epsilon'\right)g(a,z,\epsilon')\,d\epsilon' \end{aligned} \tag{A.2}$$

Figure A.1: Self-Employment Rate by Decile of Earnings: Role of Labor Frictions




***Note:*** *The figure reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model with unemployment risk. The yellow squares correspond to the alternative model without unemployment risk.*

## A.3 Model performance

When we abstract from unemployment risk we cannot generate the u-shaped pattern between income and self-employment. Figure A.1 shows the pattern of self-employment across the earnings distribution for the model without unemployment risk presented outlined above. Without unemployment, labor income constitutes a lower bound for earnings and self-employment concentrates among high earners exclusively.

The presence of unemployment risk and low-earning self-employed agents also plays a crucial role in generating the low response of wages to the increase in labor demand. The increase in wages required to meet the additional demand in the model without unemployment risk is an order of magnitude larger than what is implied by the experimental evidence and our baseline model, producing an elasticity of wage to labor demand of 1.6. As with the joint distribution of self-employment and earnings, the data reject the model without unemployment risk in policy-relevant dimensions.

# B Computational appendix

## B.1 Solution to HJB equations

The model is solved using an implicit finite difference method as the one shown in Achdou, Han, Lasry, Lions, and Moll (2021). The occupational choice is solved through a splitting method, solving first for an auxiliary value $\tilde{V}$, the value that applies if the agent continues in the same occupation, and then solving for the occupational choice. We present a more general model that allows for separate labor efficiency and productivity processes.

Consider grids over assets, entrepreneurial ability and labor efficiency:

$$\vec{a} = [a_1, \ldots, a_{n_a}] \qquad \vec{z} = [z_1, \ldots, z_{n_z}] \qquad \vec{\epsilon} = [\epsilon_1, \ldots, \epsilon_{n_\epsilon}]$$

with $n_a$, $n_z$ and $n_\epsilon$ elements respectively, and constant distance between grid points of $\Delta a$, $\Delta z$ and $\Delta \epsilon$. Let $i$ denote the index of the asset dimension, $j$ of the entrepreneurial ability, and $k$ of the labor efficiency.

For notational convenience we will treat all value functions as depending on all three states, it is understood that $V^U$ and $V^S$ do not vary across $\epsilon$. Denote $V^o_{ijk} = V^o(a_i, z_j, \epsilon_k)$ and let the backward and forward difference of the value function approximate the derivative:

$$V^o_a(a_i, z_j, \epsilon_k) \approx \frac{V^o_{i+1,jk} - V^o_{ijk}}{\Delta a} = \partial_a V^o_{ijk,F} \qquad V^o_a(a_i, z_j, \epsilon_k) \approx \frac{V^o_{ijk} - V^o_{i-1,jk}}{\Delta a} = \partial_a V^o_{ijk,B} \,.$$

The problem to solve is:

$$\begin{aligned} \rho \tilde{V}^E_{ijk} &= u\left(c^E_{ijk}\right) + \partial_a V^E_{ijk} \cdot \left(y^E_{ijk} + r a_i - c^E_{ijk}\right) + \gamma^E \left(V^U_{ij} - \tilde{V}^E_{ijk}\right) \\ &\quad + \gamma^z \sum_{j'=1}^{n_z} \left(V^E_{ij'k} - \tilde{V}^E_{ijk}\right) \mathrm{Pr}^z\left(z_{j'}|z_j\right) + \gamma^\epsilon \sum_{k'=1}^{n_\epsilon} \left(V^E_{ijk'} - \tilde{V}^E_{ijk}\right) \mathrm{Pr}^\epsilon\left(\epsilon_{k'}|\epsilon_k\right) \end{aligned} \tag{B.1}$$

$$\begin{aligned} \rho \tilde{V}^U_{ij} &= u\left(c^U_{ij}\right) + \partial_a V^U_{ij} \cdot \left(y^U_{ij} + r a_i - c^U_{ij}\right) + \gamma^U \sum_{k'=1}^{n_\epsilon} \left(V^E_{ijk'} - \tilde{V}^U_{ij}\right) \mathrm{Pr}^U\left(\epsilon_{k'}\right) \mathbb{1}_{\left\{V^E_{ijk'} > V^U_{ij}\right\}} \\ &\quad + \gamma^z \sum_{j'=1}^{n_z} \left(V^U_{ij'} - \tilde{V}^U_{ij}\right) \mathrm{Pr}^z\left(z_{j'}|z_j\right) \end{aligned} \tag{B.2}$$

$$\begin{aligned} \rho \tilde{V}^S_{ij} &= u\left(c^S_{ij}\right) + \partial_a V^S_{ij} \cdot \left(y^S_{ij} + r a_i - c^S_{ij}\right) \\ &\quad + \gamma^S \sum_{k'=1}^{n_\epsilon} \left(V^E_{ijk'} - \tilde{V}^S_{ij}\right) \mathrm{Pr}^S\left(\epsilon_{k'}\right) \mathbb{1}_{\left\{V^E_{ijk'} > V^S_{ij}\right\}} + \gamma^z \sum_{j'=1}^{n_z} \left(V^S_{ij'} - \tilde{V}^S_{ij}\right) \mathrm{Pr}^z\left(z_{j'}|z_j\right) \end{aligned} \tag{B.3}$$

together with:

$$V_{ijk}^{E} = \max\left\{\tilde{V}_{ij,k}^{E}, \tilde{V}_{ij}^{U}, \tilde{V}_{ij}^{S}\right\} \tag{B.4}$$

$$V_{ij}^{U} = \max\left\{\tilde{V}_{ij}^{U}, \tilde{V}_{ij}^{S}\right\} \tag{B.5}$$

$$V_{ij}^{S} = \max\left\{\tilde{V}_{ij}^{U}, \tilde{V}_{ij}^{S}\right\} \tag{B.6}$$

The implicit method solves the following equation on $\tilde{V}_{ijk}^{o,n+1}$ given a value for $V_{ijk}^{o,n}$. For employment the equation is:

$$\begin{aligned}\frac{\tilde{V}_{ijk}^{E,n+1} - \tilde{V}_{ijk}^{E,n}}{\Delta} + \rho\tilde{V}_{ijk}^{E,n+1} = u\left(c_{ijk}^{E,n}\right) &+ \partial_a\tilde{V}_{ijk}^{E,n+1} \cdot s_{ijk}^{E,n} + \gamma^E\left(\tilde{V}_{ij}^{U,n+1} - \tilde{V}_{ijk}^{E,n+1}\right) \\ &+ \gamma^z\sum_{j'=1}^{n_z}\left(\tilde{V}_{ij'k}^{E,n+1} - \tilde{V}_{ijk}^{E,n+1}\right)\Pr^z\left(z_{j'}|z_j\right) \\ &+ \gamma^\epsilon\sum_{k'=1}^{n_\epsilon}\left(\tilde{V}_{ijk'}^{E,n+1} - \tilde{V}_{ijk}^{E,n+1}\right)\Pr^\epsilon\left(\epsilon_{k'}|\epsilon_k\right)\end{aligned} \tag{B.7}$$

For $o \in \{U, S\}$ the equation is:

$$\begin{aligned}\frac{\tilde{V}_{ij}^{o,n+1} - \tilde{V}_{ij}^{o,n}}{\Delta} + \rho\tilde{V}_{ij}^{o,n+1} = u\left(c_{ij}^{o,n}\right) + \partial_a\tilde{V}_{ij}^{o,n+1} \cdot s_{ij}^{o,n} &+ \sum_{k'=1}^{n_\epsilon}\tilde{\gamma}_{ijk'}^{o,n}\left(\tilde{V}_{ijk'}^{E,n+1} - \tilde{V}_{ij}^{o,n+1}\right)\Pr^o\left(\epsilon_{k'}\right) \\ &+ \gamma^z\sum_{j'=1}^{n_z}\left(\tilde{V}_{ij'}^{o,n+1} - \tilde{V}_{ij}^{o,n+1}\right)\Pr^z\left(z_{j'}|z_j\right)\end{aligned} \tag{B.8}$$

Note that the (known) value at iteration $n$ is used to compute consumption, and the drift of the assets, which we will call savings for convenience:

$$s_{ijk}^{o,n} = y_{ijk}^{o} + ra_i - c_{ijk}^{o,n} \qquad \text{where} \qquad c_{ijk}^{o,n} = u^{'-1}\left(\partial_a V_{ijk}^{o,n}\right)$$

It is also used to define if the agent is willing to change after a job offer. We have:

$$\tilde{\gamma}_{ijk}^{U,n} = \gamma^U \mathbb{1}_{\left\{V_{ijk'}^{E,n} > V_{ij}^{U,n}\right\}} \qquad \tilde{\gamma}_{ijk}^{S,n} = \gamma^S \mathbb{1}_{\left\{V_{ijk'}^{E,n} > V_{ij}^{S,n}\right\}}$$

Next it is necessary to determine whether to use the forward or backward approximation to the first derivatives of the value function. We follow the "upwind scheme" presented in Achdou et al. (2021).

Since consumption can be defined with the backward or forward difference approximation we get:

$$s_{ijk,B}^{o,n} = y_{ijk}^{o} + ra_i - u^{'-1}\left(\partial_a V_{ijk,B}^{o,n}\right) \qquad s_{ijk,F}^{o,n} = y_{ijk}^{o} + ra_i - u^{'-1}\left(\partial_a V_{ijk,F}^{o,n}\right)$$

The idea is to use the backward difference when the implied drift is negative, and the forward difference when the drift is positive. Yet there are cases for which $s^{o,n}_{ijk,F} < 0 < s^{o,n}_{ijk,B}$, in these cases we set savings equal to zero, so the derivative is not used, in any case the FOC of the problem gives the exact derivate of the value function as: $\partial_a \overline{V}^{o,n}_{ijk} = u^{'}\left(y_{jk} + ra_i\right)$.[19]

Consumption is then:

$$c^{o,n}_{ijk} = u^{'-1}\left(\partial_a V^{o,n}_{ijk,B}\right)\mathbb{1}_{\left\{s^{o,n}_{ijk,B}<0\right\}} + u^{'-1}\left(\partial_a V^{o,n}_{ijk,F}\right)\mathbb{1}_{\left\{s^{o,n}_{ijk,F}>0\right\}} + \left(y^o_{ijk} + ra_i\right)\mathbb{1}_{\left\{s^{o,n}_{ijk,F}<0<s^{o,n}_{ijk,B}\right\}},$$

and the drift term for assets is replaced by:

$$\begin{aligned} \partial_a \tilde{V}^{o,n+1}_{ijk} \cdot s^{o,n}_{ijk} &= \partial_a \tilde{V}^{o,n+1}_{ijk,B}\left[s^{o,n}_{ijk,B}\right]^- + \partial_a \tilde{V}^{o,n+1}_{ijk,F}\left[s^{o,n}_{ijk,F}\right]^+ \\ &= \frac{\tilde{V}^{o,n+1}_{ijk} - \tilde{V}^{o,n+1}_{i-1,jk}}{\Delta a}\left[s^{o,n}_{ijk,B}\right]^- + \frac{\tilde{V}^{o,n+1}_{i+1,jk} - \tilde{V}^{o,n+1}_{ijk}}{\Delta a}\left[s^{o,n}_{ijk,F}\right]^+ \end{aligned}$$

Grouping terms we get the following expression for employment:

$$\begin{aligned} \frac{\tilde{V}^{E,n+1}_{ijk} - \tilde{V}^{E,n}_{ijk}}{\Delta} + \rho \tilde{V}^{E,n+1}_{ijk} = u\left(c^{E,n}_{ijk}\right) &+ \gamma^E \tilde{V}^{U,n+1}_{ij} \\ &+ x^E_{ijk}\tilde{V}^{E,n+1}_{ijk} + x^{E-}_{ijk}\tilde{V}^{E,n+1}_{i-1,jk} + x^{E+}_{ijk}\tilde{V}^{E,n+1}_{i+1,jk} \\ &+ \gamma^z \sum_{j'=1}^{n_z} \mathrm{Pr}^z\left(z_{j'}|z_j\right)\tilde{V}^{E,n+1}_{ij'k} + \gamma^\epsilon \sum_{k'=1}^{n_\epsilon} \mathrm{Pr}^\epsilon\left(\epsilon_{k'}|\epsilon_k\right)\tilde{V}^{E,n+1}_{ijk'} \end{aligned}$$

where

$$\begin{aligned} x^E_{ijk} &= \frac{\left[s^{E,n}_{ijk,B}\right]^-}{\Delta a} - \frac{\left[s^{E,n}_{ijk,F}\right]^+}{\Delta a} - \gamma^E - \gamma^z - \gamma^\epsilon \\ x^{E-}_{ijk} &= -\frac{\left[s^{E,n}_{ijk,B}\right]^-}{\Delta a} \\ x^{E+}_{ijk} &= \frac{\left[s^{E,n}_{ijk,F}\right]^+}{\Delta a} \end{aligned}$$

[19] Additional care is needed because of the non-convexities introduced by the occupational choice of agents. It is possible that both $s^{o,n}_{ijk,B} < 0$ and that $s^{o,n}_{ijk,F} > 0$ for the same state. In this case we take the drift that provides the highest change in value by comparing $u\left(c^{o,n}_{ijk,B}\right) + \partial_a V^{o,n}_{ijk,B} \cdot s^{o,n}_{ijk,B}$ with $u\left(c^{o,n}_{ijk,F}\right) + \partial_a V^{o,n}_{ijk,F} \cdot s^{o,n}_{ijk,F}$. We omit this from the notation for readability.

For unemployment and self-employment:

$$\frac{\tilde{V}_{ij}^{o,n+1}-\tilde{V}_{ij}^{o,n}}{\Delta}+\rho\tilde{V}_{ij}^{o,n+1}=u\left(c_{ij}^{o,n}\right)+\sum_{k'=1}^{n_\epsilon}\tilde{\gamma}_{ijk'}^{o,n}\Pr{}^{o}\left(\epsilon_{k'}\right)\tilde{V}_{ijk'}^{E,n+1}$$
$$+x_{ij}^{o}\tilde{V}_{ij}^{o,n+1}+x_{ij}^{o-}\tilde{V}_{i-1,j}^{o,n+1}+x_{ij}^{o+}\tilde{V}_{i+1,j}^{o,n+1}$$
$$+\gamma^{z}\sum_{j'=1}^{n_z}\Pr{}^{z}\left(z_{j'}|z_j\right)\tilde{V}_{ij'}^{o,n+1}$$

where

$$x_{ij}^{o}=\frac{\left[s_{ij,B}^{o,n}\right]^{-}}{\Delta a}-\frac{\left[s_{ij,F}^{o,n}\right]^{+}}{\Delta a}-\sum_{k'=1}^{n_\epsilon}\tilde{\gamma}_{ijk'}^{o,n}\Pr{}^{o}\left(\epsilon_{k'}\right)-\gamma^{z}$$
$$x_{ij}^{o-}=-\frac{\left[s_{ij,B}^{o,n}\right]^{-}}{\Delta a}$$
$$x_{ij}^{o+}=\frac{\left[s_{ij,F}^{o,n}\right]^{+}}{\Delta a}$$

### B.1.1 Boundary Conditions

A final loose end before writing up the linear system in matrix form is what to do with the boundaries of the different grids. At the lower boundary of the asset grid the agent is subject to a no-borrowing constraint. Hence it has to be the case that the agent does not try to borrow. The drift has to be non-negative at that point, which implies that $\tilde{x}_{1jk}^{o-}=0$ for all $(j,k)$. At the upper boundary a similar constraint can be imposed, so that $\tilde{x}_{n_a jk}^{o+}=0$. This should arise naturally if the upper boundary is high enough. Notice that imposing these restrictions implies that $V_{0j}^{n+1}$ and $V_{n_a+1,j}^{n+1}$ are not part of the system.

### B.1.2 System Solution

The equations above describe a system of $n_a \times n_z\left(2+n_\epsilon\right)$ equations, its best to define the value function a stack of three value functions, one for each occupation:

$$V=\left[V^{U};V^{S};V^{E}\right]^{T}$$
$$V^{o}=\text{vec}\left[V_{ijk}^{o}\right]$$

The system is:

$$\frac{1}{\Delta}\left(V^{n+1}-V^{n}\right)+\rho V^{n+1}=u^{n}+A^{n}V^{n+1}$$

where $u^{n}=\left[u^{U,n};u^{S,n};u^{E,n}\right]$ and $u^{o,n}=\text{vec}\left[u\left(c_{ijk}^{o,n}\right)\right]$ with consumption computed as explained above.

Matrix $A^n$ is given by:

$$A^n = B^n + C + D$$

$$B^n = \begin{bmatrix} B^n_{UU} & \mathbf{0} & B^n_{UE} \\ \mathbf{0} & B^n_{SS} & B^n_{SE} \\ B_{EU} & \mathbf{0} & B^n_{EE} \end{bmatrix} \qquad C = \begin{bmatrix} \tilde{C} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \tilde{C} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \tilde{C}_E \end{bmatrix} \qquad D = \begin{bmatrix} \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \tilde{D} \end{bmatrix}$$

The matrices $B^n_{oo}$ are sparse and they only contain elements in the diagonal, upper diagonal and lower diagonal. Consider $X_o = \left[\tilde{x}^o_{ijk}\right]$, $X^-_o = \left[\tilde{x}^{o,-}_{ijk}\right]$ and $X^+_o = \left[\tilde{x}^{o,+}_{ijk}\right]$, all three dimensional matrix that contain the coefficients $\tilde{x}$ (note that $\tilde{x}$ is already adjusted for the boundaries). Then we have: $\text{diag}\left(B^n_{oo}\right) = \text{vec}\left(X_o\right)$, $\text{diag}^+\left(B^n_{oo}\right) = \text{vec}\left(X^+_o\right)$ and $\text{diag}^-\left(B^n_{oo}\right) = \text{vec}\left(X^-_o\right)$, where the upper diagonal and lower diagonal are adjusted not to include the zero terms of the boundaries.

The matrices $B^n_{oo'}$ depend on the type of transition. For the transition from employment to unemployment we have:

$$B_{EU} = \gamma^E \begin{bmatrix} I_{n_a \cdot n_z} \\ \vdots \\ I_{n_a \cdot n_z} \end{bmatrix}$$

so that $B_{EU}$ is of size $n_a \cdot n_z \cdot n_\epsilon \times n_a \cdot n_z$. For the transition from unemployment and self-employment to employment:

$$B^n_{oE} = \gamma^o \left[ \; \text{Pr}^o\left(\epsilon_1\right) \text{diag}\left(\text{vec}\left(\mathbb{1}_{\left\{V^E_{ij1} > V^o_{ij}\right\}}\right)\right) \quad \cdots \quad \text{Pr}^o\left(\epsilon_{n_\epsilon}\right) \text{diag}\left(\text{vec}\left(\mathbb{1}_{\left\{V^E_{ijn_\epsilon} > V^o_{ij}\right\}}\right)\right) \; \right]$$

where we abuse notation by letting $\text{diag}\left(\cdot\right)$ give a diagonal matrix when it is evaluated in a vector.

Matrices $\tilde{C}$ and $\tilde{D}$ are also sparse and they are independent of the iteration. Their construction takes advantage of the fact that the elements of $\tilde{C}$ only vary with $j$ and the elements of $\tilde{D}$ only vary with $k$. We first construct $\tilde{C} = \gamma^z \text{Pr}^z \otimes I_{n_a}$ and $\tilde{C}_E = \gamma_z I_{n_\epsilon} \otimes \tilde{C}$. Finally, $\tilde{D} = \gamma^\epsilon \text{Pr}^\epsilon \otimes I_{n_a \cdot n_z}$.

This problem can now be expressed as:

$$T^n V^{n+1} = t^n$$

where:

$$T^n = \left(\frac{1}{\Delta} + \rho\right) I_{n_a n_z (2+n_\epsilon)} - A^n \qquad t^n = u^n + \frac{1}{\Delta} V^n$$

#### B.1.3 Algorithm

1. Compute matrices $C$ and $D$. These matrices do not change with equilibrium prices or iterations.
2. Take as given $w$.
3. Solve for earnings in each state: $y^o_{ijk}$ for each combination of $(a, z, \epsilon)$ and

occupation. These values don't change with iterations.

4. Guess a value for $V^n$, a $n_a n_z (2+n_\epsilon)$ vector. It is easier to store it as three separate matrices of dimensions $n_a \times n_z$, $n_a \times n_z$ and $n_a \times n_\epsilon \times n_z$.
   (a) We find it better to find the initial condition by solving for a fixed point of the problem without occupational choice (this same algorithm without the last step).
5. Compute the backward and forward drift: $s^{o,n}_{ijk,B}$ and $s^{o,n}_{ijk,F}$ for $i = \{2,\dots,n_a\}$ and $i = \{1,\dots,n_a - 1\}$ respectively, and all $(j,k,o)$.

$$s^{o,n}_{ijk,B} = y^o_{jk} + ra_i - u^{'-1}\left(\partial_a V^{o,n}_{ijk,B}\right) \qquad s^{o,n}_{ijk,F} = y^o_{jk} + ra_i - u^{'-1}\left(\partial_a V^{o,n}_{ijk,F}\right)$$

   These values are stored in six matrices (two per occupation, one with backward drift and the other one with forward drift).
6. For all $(i,j,k,o)$ compute consumption as:

$$c^{o,n}_{ijk} = u^{'-1}\left(\partial_a V^{o,n}_{ijk,B}\right) 1_{s^{o,n}_{ijk,B}<0} + u^{'-1}\left(\partial_a V^{o,n}_{ijk,F}\right) 1_{s^{o,n}_{ijk,F}>0} + \left(y^o_{jk} + ra_i\right) 1_{s^{o,n}_{ijk,F}<0<s^{o,n}_{ijk,B}}$$

   These values are stored in three matrices of dimensions $n_a \times n_z$, $n_a \times n_z$ and $n_a \times n_\epsilon \times n_z$.
7. Compute the utility vector as: $u^n = \left[u^{U,n}; u^{S,n}; u^{E,n}\right]$ and $u^{o,n} = \text{vec}\left[u\left(c^{o,n}_{ijk}\right)\right]$.
8. Compute the adjusted shock arrival rates:

$$\tilde{\gamma}^{U,n}_{ijk} = \gamma^U 1_{V^{E,n}_{ijk} > V^{U,n}_{ijk}} \qquad \tilde{\gamma}^{S,n}_{ijk} = \gamma^S 1_{V^{E,n}_{ijk} > V^{U,n}_{ijk}} \qquad \tilde{\gamma}^{E,n}_{ijk} = \gamma^E$$

9. Compute the matrices $X_o = \left[\tilde{x}^o_{ijk}\right]$, $X^-_o = \left[\tilde{x}^{o,-}_{ijk}\right]$ and $X^+_o = \left[\tilde{x}^{o,+}_{ijk}\right]$.
10. Compute matrix $B^n = \begin{bmatrix} B^n_{UU} & \mathbf{0} & B^n_{UE} \\ \mathbf{0} & B^n_{SS} & B^n_{SE} \\ B^n_{EU} & \mathbf{0} & B^n_{EE} \end{bmatrix}$, where $\text{diag}\left(B^n_{oo}\right) = \text{vec}\left(X_o\right)$, $\text{diag}^+\left(B^n_{oo}\right) = \text{vec}\left(X^+_o\right)$ and $\text{diag}^-\left(B^n_{oo}\right) = \text{vec}\left(X^-_o\right)$, where the upper diagonal and lower diagonal are adjusted not to include the zero terms of the boundaries. The matrices $B^n_{oo'}$ are defined above.
11. Compute the matrix $A^n = B^n + C + D$.
12. Compute the matrix $T$ and vector $t$:

$$T^n = \left(\frac{1}{\Delta} + \rho\right) I_{3n_a n_\epsilon n_z} - A^n \qquad t^n = u^n + \frac{1}{\Delta} V^n$$

13. Compute $V^{n+1/2}$ as:

$$V^{n+1/2} = \left(T^n\right)^{-1} t^n$$

   (a) We use the Biconjugate gradients stabilized (l) method, preconditioned with LU Factorization. See Matlab functions "ilu" and "bicgstabl."
14. Divide the vector $V^{n+1/2}$ into three matrices of $n_a \times n_z$, $n_a \times n_z$ and $n_a \times n_\epsilon \times n_z$: $V^{U,n+1/2}$, $V^{S,n+1/2}$, and $V^{E,n+1/2}$.

15. Compute $V^{U,n+1}$, $V^{S,n+1}$, and $V^{E,n+1}$ as follows:

$$V_{ijk}^{U,n+1} = \max\left\{V_{ijk}^{U,n+1/2}, \tilde{V}_{ijk}^{S}\right\}$$
$$V_{ijk}^{S,n+1} = \max\left\{V_{ijk}^{U,n+1/2}, V_{ijk}^{S,n+1/2}\right\}$$
$$V_{ijk}^{E,n+1} = \max\left\{V_{ijk}^{U,n+1/2}, \tilde{V}_{ijk}^{S}, V_{ijk}^{E,n+1/2}\right\}$$

   (a) Define the following matrices as indicators of the occupation choice: $\left[\tilde{\chi}_{ijk}^{oo'}\right]$

$$\tilde{\chi}_{ij}^{US} = \begin{cases} 1 & \text{if } V_{ij}^{U,n+1} = \tilde{V}_{ij}^{S} \\ 0 & \text{otw} \end{cases} \qquad \tilde{\chi}_{ij}^{SU} = \begin{cases} 1 & \text{if } V_{ij}^{S,n+1} = V_{ij}^{U,n+1/2} \\ 0 & \text{otw} \end{cases}$$

$$\tilde{\chi}_{ijk}^{EU} = \begin{cases} 1 & \text{if } V_{ijk}^{E,n+1} = V_{ij}^{U,n+1/2} \\ 0 & \text{otw} \end{cases} \qquad \tilde{\chi}_{ijk}^{ES} = \begin{cases} 1 & \text{if } V_{ijk}^{E,n+1} = \tilde{V}_{ij}^{S} \\ 0 & \text{otw} \end{cases}$$

   These functions are 1 if the agent changes occupations at $(i, j, k)$.

   (b) Define now the vectors $\chi^{oo'} = \text{vec}\left(\tilde{\chi}^{oo'}\right)$ to be used later. $\chi$ is a vector of length $n_a n_z (2 + n_\epsilon)$.

## B.2 Solution to KFE equations

Before solving the KFE the transition matrix $A$ has to be modified to include the endogenous transitions between unemployment and self-employment. For this we use the indicators $\chi$ constructed as part of the value function iteration.

Now, consider a transition matrix $P$:

$$P = \begin{bmatrix} P^{UU} & P^{US} & A^{UE} \\ P^{SU} & P^{SS} & A^{SE} \\ P^{EU} & P^{ES} & A^{EE} \end{bmatrix}$$

note that since there are not endogenous transitions to employment the last column of matrices are just as in matrix $A$. The other columns are modified only if there are endogenous transitions. Note that each matrix $P^{oo'}$ is of size $n_a n_\epsilon n_z \times n_a n_\epsilon n_z$.

1. Make all matrices $P^{oo'} = A^{oo'}$ and $P^{oo} = A^{oo}$.
2. For matrix $P$ make zero any (column) entry related to an endogenous transition, since these states are not reached. For all $m$ and $q$ in $\{1, \ldots, n_a n_\epsilon n_z\}$:

$$P_{mq}^{*U} = 0 \qquad \text{if } \chi^{US}(q) = 1$$

$$P_{mq}^{*S} = 0 \qquad \text{if } \chi^{SU}(q) = 1$$

$$P_{mq}^{*E} = 0 \qquad \text{if } \chi^{EU}(q) = 1 \quad \text{or} \quad \chi^{ES}(q) = 1$$

where $* \in \{U, S, E\}$.

3. For matrix $P$ adjust entries to take into account endogenous transitions coming from other occupation $o$ into occupation $o'$. This implies moving the columns of $P^{o*}$ that were set to 0 because of transitions into $P^{*o'}$. For all $m$ and $q$ in $\{1, \ldots, n_a n_\epsilon n_z\}$:

$$P_{m,q-l_q}^{*S} = P_{m,q-l_q}^{*S} + A_{mq}^{*U} \qquad \text{if } \chi^{US}(q) = 1$$

$$P_{mq}^{*U} = P_{mq}^{*U} + A_{mq}^{*S} \qquad \text{if } \chi^{SU}(q) = 1$$

$$P_{mq}^{*U} = P_{mq}^{*U} + A_{mq}^{*E} \qquad \text{if } \chi^{EU}(q) = 1$$

$$P_{m,q-l_q}^{*S} = P_{m,q-l_q}^{*S} + A_{mq}^{*E} \qquad \text{if } \chi^{ES}(q) = 1$$

where $l_q$ maps the index of the agent after paying the $l_k$ units of adjustment cost.

4. Finally as explained in Moll's example for stopping time (multiple assets with adjustment costs) the diagonal elements with transitions have to be adjusted:

$$P_{mm}^{UU} = \frac{-1}{\Delta} \qquad \text{if } \chi^{US}(m) = 1$$

$$P_{mm}^{SS} = \frac{-1}{\Delta} \qquad \text{if } \chi^{SU}(m) = 1$$

$$P_{mm}^{EE} = \frac{-1}{\Delta} \qquad \text{if } \chi^{EU}(m) = 1 \quad \text{or} \quad \chi^{ES}(m) = 1$$

Moll says: "To see why the $^{-1}/_{\Delta}$ term shows up, consider the time-discretized process for $g$:

$$\dot{g}_t = P^T g_t \longrightarrow g_{t+\Delta t} = (\Delta P + I)^T g_t$$

where $I$ is the identity matrix. The transition matrix $\tilde{P} = \Delta P + I$ needs to have all entries in the adjustment region $\tilde{C}_{mm} = 0$ and hence $\Delta P + I = 0$. Without the adjustment, the matrix $P$ is singular.

The system to solve is:

$$P^T g = 0$$

A simple way to solve the system is to make one of the elements of $g$ to be equal to an arbitrary number, and replace such row of $P^T$ by a row of zeros with a one in the diagonal. Call this matrix $\tilde{P}^T$ and let $\tilde{\iota} = [0, \ldots, 0, 0.1, 0, \ldots, 0]^T$ then solve for:

$$\tilde{g} = \left[\tilde{P}^T\right]^{-1} \tilde{\iota}$$

Normalize $\tilde{g}$ so that it sums to 1: $\tilde{g} = {}^{\tilde{g}}/_{\text{sum}(\tilde{g})}$. Finally define $g$ as:

$$g_i = \frac{\tilde{g}_i}{\Delta a_i}$$

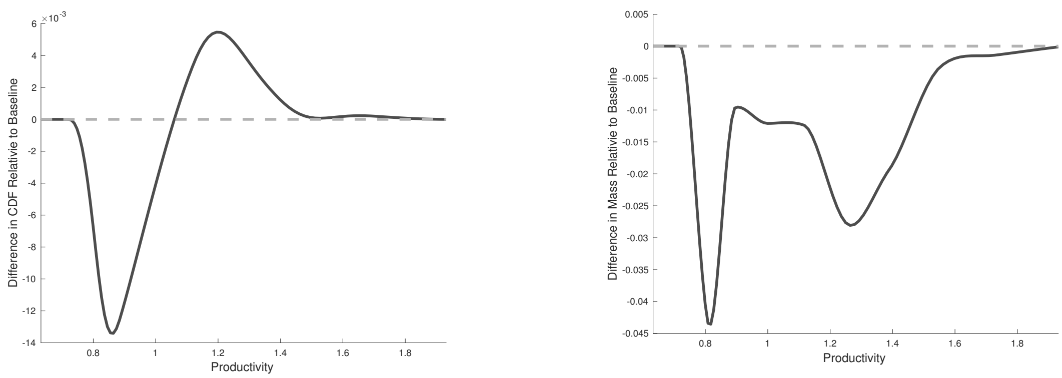
# C Model: additional graphs and tables

## C.1 Job-guarantee programs

We use the model to simulate the effects of a labor demand shock as described in Section 3. The model implies a reallocation of the workforce from self-employment into both higher employment and unemployment. The decrease in self-employment comes mostly from low-productivity agents; because of this, the productivity distribution improves relative to the baseline (in the first-order stochastic dominance sense). Figure C.1 makes this clear by showing the changes in the distribution of productivity among the self-employed. The mass of self-employment decreases throughout, Figure C.1b, but the decrease is concentrated at the bottom of the distribution.

Figure C.1: Productivity Changes after Labor Demand Shock

(a) Difference of Cumulative Distributions (b) Difference of Mass per $z-$type




***Note:*** *The figures show changes in the distribution of productivity ($z$) between the equilibrium of the baseline model and the model with government labor demand. The left panel presents the difference in the CDF of productivity among the self-employed relative to the baseline model. Negative values indicate that the new distribution first order stochastically dominates the baseline distribution. The right panel presents the difference in the mass of self-employed agents for each $z-$type. Differences are due to changes in the distribution and overall mass of self-employed agents.*

## C.2 Financial sector reform

We study the role of the collateral constraint in the model by increasing the value of $\lambda$. This change is qualitatively different from the policies we explore in Section 4, where we simulate the effects of expanding the credit limit of the self-employed by a fixed amount. Although both types of exercise loosen financial constraints, an increase in $\lambda$ maintains the dependence of credit on the individual's asset holdings. First, we study the effects of a moderate reform that loosens the collateral constraint of the self-employed. Second, we compare these results with those following a complete elimination of credit frictions.

**Credit Deepening** We introduce a partial loosening of self-employed agents' collateral constraints. The new collateral constraint is

$$k \leq (\lambda + \lambda_{cd}) \cdot a, \tag{C.1}$$

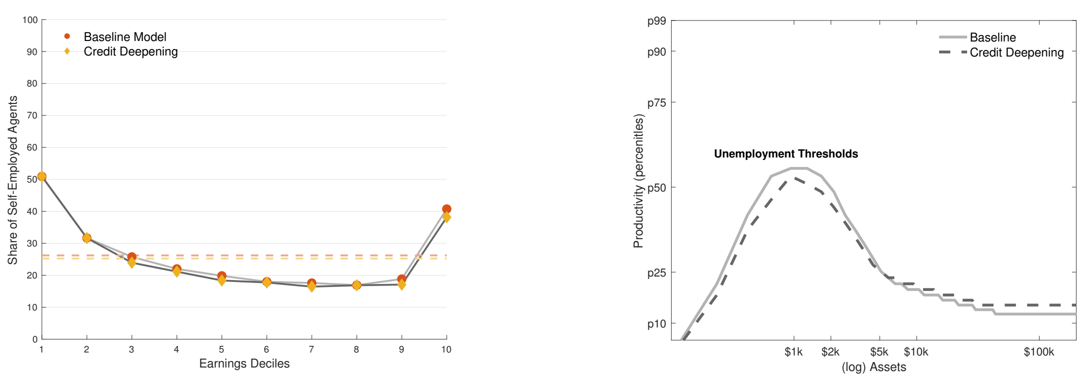
where $\lambda_{cd}$ is set to make the constraint 20 percent less stringent than in the baseline.

We find that the effects of the reform are muted due to the reaction of prices in general equilibrium. In partial equilibrium, the loosening of the collateral constraint induces individuals to enter into self-employment.With fixed prices, the reform increases self-employment by 3.72 percentage points. The change is mostly matched by a decrease in employment of 3.34 percentage points. However, most of these occupational changes dissipatewhen the wage rate increases in order to clear the labor market. Figure C.2 shows that there are small changes in the distribution of the self-employed and the occupational choices of agents. The main differences are a slight increase in productivity threshold for wealthy individuals (explained by the increase in wages) and a slight decrease for poor individuals (explained by the availability of credit).

The final result of the reform is a decrease in the self-employment rate of around 0.98 percentage points, and an increase of the unemployment rate of 0.54 percentage points. These results are reminiscent of the channels highlighted by Feng, Lagakos, and Rauch (2020). As economies develop, unemployment is created as a byproduct. Because capital can be assigned more efficiently to high-productivity entrepreneurs, the reform increases TFP in 0.9 percent and is the main driver behind an increase in aggregate output of 1.1 percent.

Figure C.2: Model Response to Credit Deepening

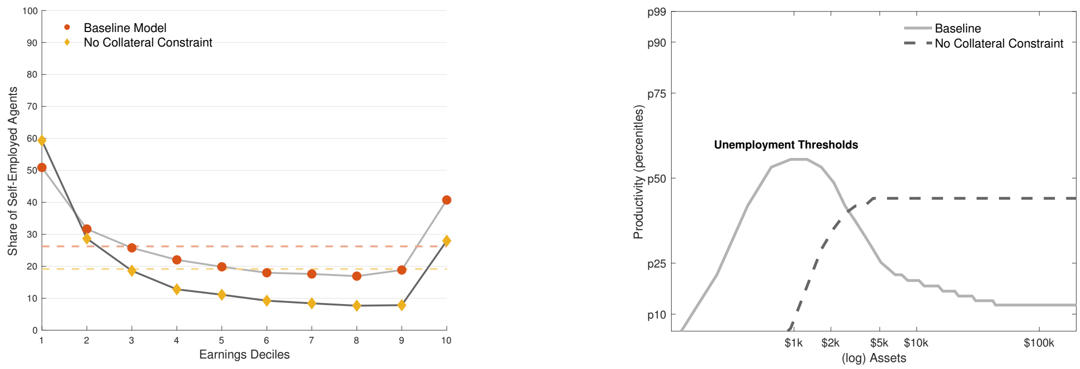
(a) General Equilibrium (b) Occupational Choice




*Note:* *The left panel reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model. The yellow squares correspond to the model with a credit-deepening reform. The right panel reports productivity thresholds characterizing the occupational choice of unemployed agents for the baseline model (continuous light gray line) and the model with credit deepening (dashed dark gray line). Lines depict the threshold value of productivity ($z$) for each level of assets ($a$). The agent chooses self-employment if productivity is above the threshold.*

Figure C.3: Model without Collateral Constraints

(a) Self-Employment Rate (b) Occupational Choice




***Note:*** *Panel (a) reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model. The yellow squares correspond to the model without collateral constraints. Panel (b) reports productivity thresholds characterizing the occupational choice of unemployed agents for the baseline model (continuous light gray line) and the model without collateral constraint (dashed dark gray line). The agent chooses self-employment if productivity is above the threshold.*

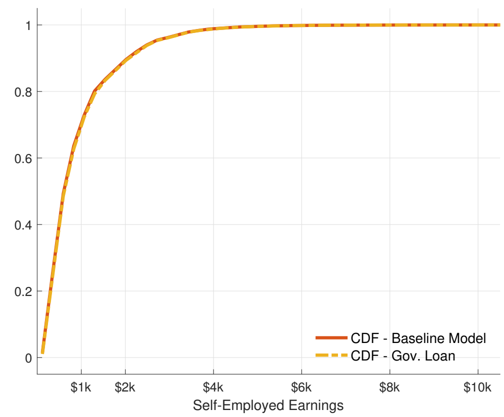
**Elimination of Collateral Constraints ($\lambda_{cd}\to\infty$)** Financial reform, even when taken to the limit of eliminating collateral constraints, does not solve the subsistence concerns that lead poor individuals to choose self-employment. Figure C.3b shows that for sufficiently rich agents, the reform makes selection into self-employment flat with respect to wealth. Nevertheless, the model still predicts an increasing profile of selection for sufficiently poor agents who face have subsistence concerns while unemployed. The elimination of collateral constraints does not do away with the liquidity constraints of unemployment agents, nor the labor frictions that prevent individuals from becoming employed. In this way, the u-shape pattern of self-employment along the earnings distribution is preserved as seen in Figure C.3a.

In the aggregate, financial sector reforms are beneficial to productivity and generate unemployment as a byproduct, as more individuals move from low-productivity self-employment activities into frictional labor markets. The self-employment rate goes down by 7 percentage points and unemployment goes up by 4.5 percentage points. Output increases by 32 percent, and TFP by 11 percent. In order to clear the labor market, the wage rate goes up by 19 percent.

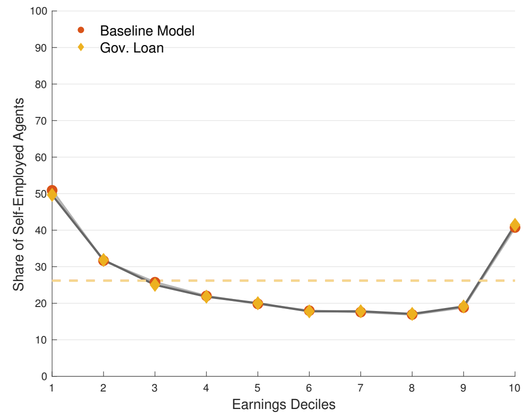
The effects of financial reforms illustrate the importance of general equilibrium analysis. While the partial equilibrium effects of the reform point to a large increase in self-employment, the general equilibrium analysis shows those conclusions would be premature. As firms have better access to credit, productive firms grow and increase the overall productivity of the economy. This invariably leads to higher wages, which in turn affect agents' occupational choices. The net effect of these reforms is likely to be a better selection into self-employment, with fewer but more successful self-employed agents.

Figure C.4: Model Response to Increase in Credit in Partial Equilibrium

(a) CDF of Self-Employed Earnings




(b) Self-Employment Rate




***Note:*** *The left panel reports the CDF of the earnings of the self-employed in the model. The continuous red line corresponds to the baseline model. The dashed yellow line corresponds to the model with expanded credit access in partial equilibrium. The right panel reports the share of self-employed agents for each decile of the earnings distribution.The red circles correspond to the baseline model. The yellow squares correspond to the model with expanded credit access in partial equilibrium.*

## C.3 Policy analysis: Additional results

We present here additional results for the analysis of micro-credit and transfers to unemployed and non-employed individuals.

Figure C.4 is the partial equilibrium counterpart of Figure 4. Both figures exhibit the same behavior, mostly slight changes with respect to the baseline model.

Table C.1 and Figure C.5 report the changes in model aggregates and the behavior of agents after the introduction of transfers to the non-employed (i.e., both unemployed and self-employed individuals receive the transfer). Transfers effectively alleviate subsistence concerns for the poorest agents as reflected in the increase in the threshold productivity for them to become self-employed (Figure C.5c). However, the policy also decreases overall savings by 1.9 percentage points. This decrease is concentrated on the unemployed, whose assets go down over 9 percent. The result is a shift of the distribution of agents towards poorer individuals. In the net self-employment increases by 0.36 percentage points, but aggregate productivity (TFP) falls 0.32 percent. The decrease in productivity is partly responding to larger distortions caused by the deaccumulation of assets. Nevertheless, the effects remain small at the micro level. See, for instance, the changes in the distribution of self-employment earnings in Figure C.5a.

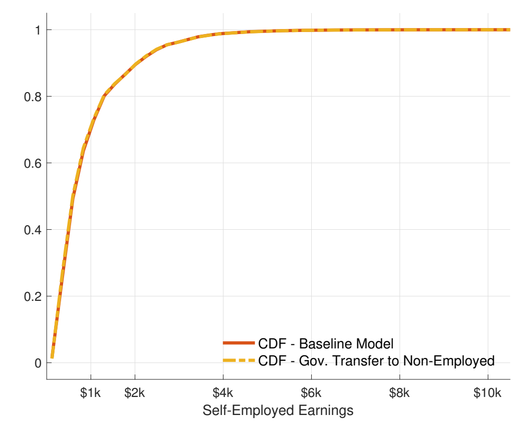
| Variable | Δ | Variable | %Δ | Variable | %Δ |
|---|---|---|---|---|---|
| Employment | −0.22 | TFP | −0.32 | % Output | −0.04 |
| Unemployment | −0.14 | Income(E) | −0.01 | Consumption | −0.61 |
| Self-Employment | 0.36 | Income(SE) | −1.40 | Assets | −1.90 |

Table C.1: Model Response to Transfers to the Non-Employed

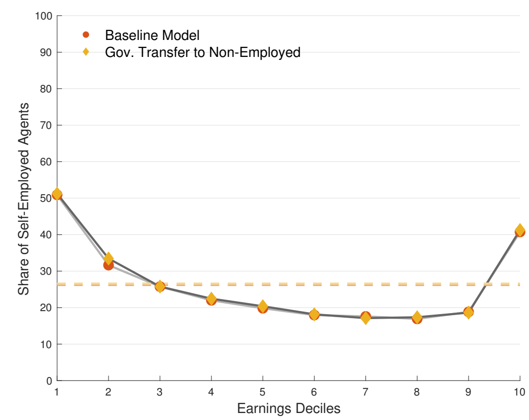
***Note:*** *The table presents changes in variables with respect to the baseline model after the introduction of transfers to the unemployed. All numbers are in percentage points.*

Figure C.5: Model Response to Transfers to the Non-Employed

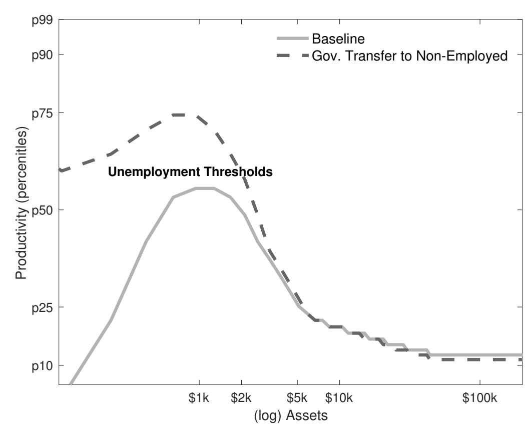
(a) CDF of Self-Employed Earnings




(b) Self-Employment Rate




(c) Occupational Choice




***Note:*** *Panel (a) reports the CDF of the earnings of the self-employed in the model. The continuous red line corresponds to the baseline model. The dashed yellow line corresponds to the model with transfers to the non-employed in general equilibrium. Panel (b) reports the share of self-employed agents for each decile of the earnings distribution.The red circles correspond to the baseline model. The yellow squares correspond to the model with transfers to the non-employed in general equilibrium. Panel (c) reports productivity thresholds characterizing the occupational choice of unemployed agents for the baseline model (continuous light gray line) and the model with credit deepening (dashed dark gray line). Lines depict the threshold value of productivity ($z$) for each level of assets ($a$). The agent chooses self-employment if productivity is above the threshold.*

## C.4 Income-targeted cash transfers

Providing cash transfers to low-income individuals is one of the most ubiquitous policies in the developing world. Transfers in low- and middle-income countries reach 11 percent of their population and amount to roughly 18 percent of the expenditures of recipient households (Banerjee, Niehaus, and Suri, 2019) .

To be consistent with these figures, we provide a transfer targeting the poorest 10% in terms of income in the baseline model. The transfer amounts to 15% of this group's consumption expenditures, or roughly 17% of the mean average labor income in the economy. Importantly, the targeting is independent of the individual's occupation or other variables such as wealth.

**Targeted cash transfers in partial equilibrium** Unlike transfers targeted to the unemployed, transfers given to the poor, irrespective of their occupation, lead to less productive self-employed agents. Figure C.6a shows that the distribution of productivity worsens (in the FOSD sense) after the introduction of the transfers. This can seem surprising, given the change in the productivity threshold that characterizes the occupational choice of the unemployed (Figure C.6b). Self-employment becomes less attractive for the poorest among the unemployed, but it also becomes more attractive for relatively wealthier agents with low productivity. At the same time, the transfers induce agents to save less. In fact, asset holdings go down 35 percent in the economy—39 percent among the self-employed. Daruich and Fernandez (2021) found similar effects on savings when analyzing the effects of Universal Basic Income. The combination of these two effects leads to a pool of self-employed agents that are less productive and less wealthy.

The consequences of the change in selection and savings are made apparent by the distribution of self-employment across the earnings distribution. Figure C.7a shows that the reduction in self-employment (3.8 percentage points) is concentrated among high earners, with a smaller decline among the bottom 10 percent of earners.

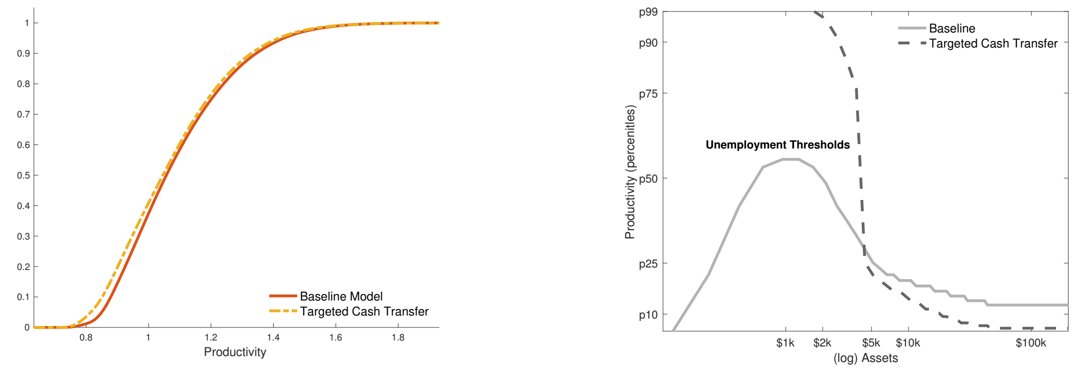
**Targeted cash transfers in general equilibrium** The fall in self-employment, particularly among top earners, is undone in general equilibrium. Figure C.7b makes this clear. As for the case of transfers to the unemployed, these effects are driven by lower wages and higher labor income taxes required to finance the transfers (after tax wages decrease 3.76 percent). Both changes simultaneously make unemployment/employment less attractive and make self-employment more profitable for highly productive agents.

In equilibrium, the introduction of targeted cash transfers incentivizes self-employment (which goes up 1.15 percentage points), at the expense of salaried employment (which goes down 1.04 percentage points). These changes are consistent with cross-sectional results by Bianchi and Bobba (2013), who compared treated and control regions after the enactment of *Progresa*, a large conditional cash transfer

Figure C.6: Model Response to Targeted Cash Transfers in Partial Equilibrium

(a) CDF of Productivity

(b) Occupational Choice




***Note:*** *The left panel reports the CDF of productivity among self-employed agents. The continuous red line corresponds to the baseline model. The dashed yellow line corresponds to the model with targeted cash transfers in partial equilibrium. The right panel reports productivity thresholds characterizing the occupational choice of unemployed agents for the baseline model (continuous light gray line) and the model with targeted cash transfers (dashed dark gray line). Lines depict the threshold value of productivity* $(z)$ *for each level of assets* $(a)$*. The agent chooses self-employment if productivity is above the threshold.*

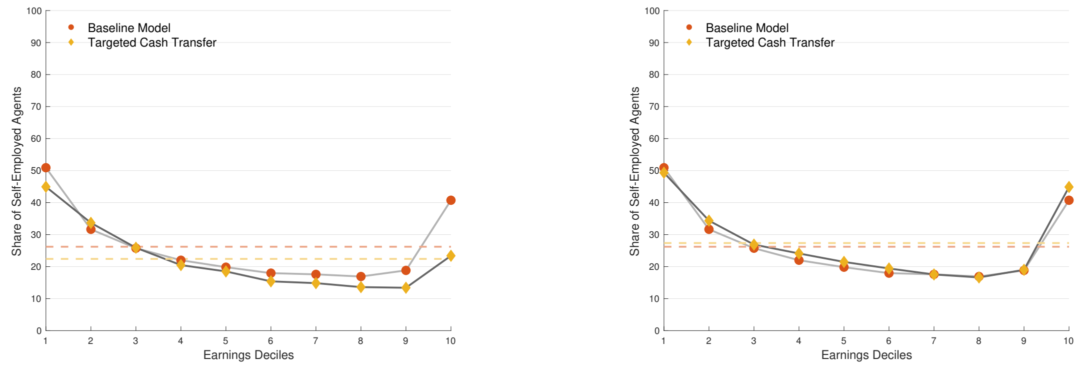
program in Mexico.

Despite reversing some of the changes to self-employment, the worsening of the productivity distribution among the self-employed is not undone in general equilibrium. On top of this, the decrease in asset holdings among the self-employed makes them more constrained, further reducing productivity (see equation 14). This is reflected in a fall of aggregate TFP by 1.15 percent.

Thus, in the presence of subsistence self-employment, across-the-board income transfers entail general equilibrium effects that reverse most of the positive effects in partial equilibrium. Once we account for the behavior of wages to clear the labor market, self-employment increases and total factor productivity falls.

Figure C.7: The Self-Employment Rate and Targeted Cash Transfers

(a) Partial Equilibrium (b) General Equilibrium




***Note:*** *The figure reports the share of self-employed agents for each decile of the earnings distribution. The red circles correspond to the baseline model. The yellow squares in the left panel correspond to the model with targeted cash transfers in partial equilibrium. The yellow squares in the right panel correspond to the model with targeted cash transfers in general equilibrium.*

# D Additional reduced form analysis

## D.1 Workforce composition

Table D.1 shows the composition of the labor force in our sample and contrasts it with the composition of the whole Mexican economy and the U.S. over the period 2005-2019. Our sample behaves in a similar way to the overall Mexican labor force, while the differences between Mexico and the U.S. are apparent, particularly in the share of self-employed individuals.

| Labor Status | Our Sample | General Population | U.S. |
|---|---|---|---|
| Worker | 69.1% | 57.9% | 80.7% |
| Unemployed | 4.4% | 3.9% | 6.3% |
| Self Employed | 26.7% | 38.1% | 12.9% |

Table D.1: Workforce Composition

***Note:*** *The data for the Mexican general population are taken from the world development indicators (WDI). The data for the U.S. are taken from the current population survey (CPS).*

## D.2 Mobility across occupations

In what follows we dig deeper into how the labor market status of an individual affects transitions. To do so, we follow the same strategy as Katz and Krueger (2017) in their study of alternative work arrangements in the U.S.. The first question we ask is whether individuals who are unemployed are more likely to transition into self-employed. To

| | (1) SE | (2) SE | (3) SE | (4) SE |
|---|---|---|---|---|
| $U_{t-1}$ | 0.209*** | 0.209*** | 0.208*** | 0.208*** |
| | [0.003] | [0.003] | [0.003] | [0.003] |
| $S_{t-1}$ | 0.717*** | 0.717*** | 0.706*** | 0.706*** |
| | [0.012] | [0.012] | [0.012] | [0.012] |
| Age | | | 0.002*** | 0.002*** |
| | | | [0.000] | [0.000] |
| Constant | 0.080*** | 0.109*** | -0.027 | -0.038 |
| | [0.005] | [0.005] | [395.990] | [167.520] |
| Observations | 1033397 | 1033397 | 1033397 | 1033397 |
| Mean Ent | 0.285 | 0.285 | 0.285 | 0.285 |
| Schooling Controls | No | No | Yes | Yes |
| City Fixed Effect | No | No | No | Yes |
| Time Fixed Effect | No | Yes | Yes | Yes |
| Weighted | Yes | Yes | Yes | Yes |

Table D.2: Transitions to Self-Employment

***Note:*** *The LHS variable is an indicator variable that takes the value of one if the individual is self-employed and zero if the individual is employed. $U_{t-1}$ and $S_{t-1}$ are indicator variables that take the value of 1 if the individual was unemployed or self employed in the previous quarter respectively. Age is the age in years. Standard errors are clustered at the city level. Schooling controls are a set of dummies by education level to control non-parametrically for education. Time fixed effects are at the year-quarter level. The sample consists of individuals who are either employed or self-employed in period $t$. We run the regressions by weighted OLS. *, **, and ***, denote significance at the 10%, 5%, and 1% level.*

answer this we focus on the universe of individuals who are either employed or self-employed in period $t$, and check whether the transitions to self-employment are larger for those agents who were unemployed in the previous period.

This exercise differs from the conditional transition rates reported in Table 3. The regression in this section allows us to control for the observable characteristics of individuals, comparing transition rates across similar individuals in terms of age, education and location, instead of computing transitions among individuals with the same labor market status (e.g. unemployed). We take this evidence as only suggestive of the mechanisms we study.

Table D.2 reports the regression results. The transition rates of unemployed agents to self-employment are 20.9 percentage points higher than those exhibited by observationally comparable agents who had a salaried job. This result holds after controlling for age, education, and after adding time and city fixed-effects. While we are not able to control for all the relevant factors affecting transitions into self-employment, we interpret the higher transition rate from unemployment as suggestive of the role of self-employment as an outside option for individuals who need an income source, as opposed to self-employment representing entrepreneurial activities for which the individual is better suited (relative to working in a salaried job). Our results align with those of Katz and Krueger (2017) for the U.S.. They find that unemployed individuals are more likely to transition to an alternative work arrangement job than agents who are employed.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | E | E | E | E | E |
| $S_{t-1}$ | -0.268*** | -0.268*** | -0.255*** | -0.254*** | -0.340*** |
| | [0.021] | [0.021] | [0.020] | [0.020] | [0.014] |
| Age | | | -0.006*** | -0.006*** | -0.004*** |
| | | | [0.000] | [0.000] | [0.000] |
| Second Earner | | | | | 0.022 |
| | | | | | [0.018] |
| $S_{t-1}\times$ Second Earner | | | | | 0.024** |
| | | | | | [0.011] |
| Constant | 0.463*** | 0.417*** | 0.704*** | 0.684*** | 0.589 |
| | [0.015] | [0.014] | [0.103] | [0.111] | [1203.540] |
| Observations | 327250 | 327250 | 327250 | 327250 | 145945 |
| Mean Emp | 0.221 | 0.221 | 0.221 | 0.221 | 0.221 |
| Schooling Controls | No | No | Yes | Yes | Yes |
| Time Fixed Effect | No | Yes | Yes | Yes | Yes |
| Weighted | Yes | Yes | Yes | Yes | Yes |

Table D.3: Transitions to Employment

***Note:*** *The LHS variable is an indicator variable that takes the value of one if the individual is employed in period t. $S_{t-1}$ and Second Earner are indicator variables that take the value of 1 if the individual was self-employed and if the individual's couple was an income earner in the previous quarter respectively. Age is the age in years. Standard errors are clustered at the city level. Schooling controls are a set of dummies by education level to control non-parametrically for education. Time fixed effects are at the year-quarter level. The sample consists of individuals who were either unemployed or self-employed in period $t-1$. We run the regressions by weighted OLS. *, **, and ***, denote significance at the 10%, 5%, and 1% level.*

The second question we ask is whether individuals who become self-employed transition less to salaried jobs. The effect of self-employment on the transitions into employment matters to determine how persistent the effects of individual occupational choices are, and how policies that affect those choices affect in turn the labor market. To answer this question we focus on the universe of agents who are either unemployed or self-employed in period $t-1$, and follow them to determine whether or not they become employed. As before this allows us to compare the transition rates of self-employed individuals with comparable unemployed individuals.

Table D.3 presents the regression results. We do in fact find that self-employed individuals are 34 percentage points less likely to transition to employment than comparable unemployed individuals. Even if the actual effect of self-employment is not as large, this estimate indicates that opting into self-employment can have long-lasting implications for an individual, particularly for low-productivity self-employed who are now less likely to abandon this state and move to employment. Jackson (2020) finds similar results studying self-employed workers in the United States.

An important caveat for the results in Table D.3 is that we are not controlling for selection into self-employment on the basis of entrepreneurial ability or preference for self-employment. We also lack the full occupational history of individuals, so we cannot condition on the attachment to self-employment of each individual. However, we can partially address some of these shortcomings by focusing on individuals who were unemployed to begin with (in period $t-2$), and who then either remain unemployed or transition to self-employment (in period $t-1$). This lets us compare individuals that start in a common state, and who then differ on whether or not they transition through self-employment. When we perform this analysis the same result emerges, with individuals who become self-employed being 14.4 percentage points less likely to transition to employment in period $t$. The regression results can be found in Table D.4.

| | (1)<br>E | (2)<br>E | (3)<br>E | (4)<br>E | (5)<br>E |
|---|---|---|---|---|---|
| $S_{t-1}$ | -0.066*** | -0.069*** | -0.084*** | -0.086*** | -0.144*** |
| | [0.014] | [0.014] | [0.017] | [0.017] | [0.050] |
| Age | | | -0.009*** | -0.009*** | -0.007*** |
| | | | [0.001] | [0.001] | [0.001] |
| Second Earner | | | | | 0.035 |
| | | | | | [0.057] |
| $S_{t-1} \times$ Second Earner | | | | | -0.024 |
| | | | | | [0.058] |
| Constant | 0.383*** | 0.456*** | 0.854*** | 0.863*** | 1.327*** |
| | [0.017] | [0.064] | [0.226] | [0.228] | [0.075] |
| Observations | 7320 | 7320 | 7320 | 7320 | 3205 |
| Mean Emp | 0.355 | 0.355 | 0.355 | 0.355 | 0.355 |
| Schooling Controls | No | No | Yes | Yes | Yes |
| Time Fixed Effect | No | Yes | Yes | Yes | Yes |
| Weighted | Yes | Yes | Yes | Yes | Yes |

Table D.4: Transitions to Employment from Unemployment

***Note:*** *The LHS variable is an indicator variable that takes the value of one if the individual is employed in period t. $S_{t-1}$ and Second Earner are indicator variables that take the value of 1 if the individual was self-employed and if the individual's couple was an income earner in the previous quarter respectively. Age is the age in years. Standard errors are clustered at the city level. Schooling controls are a set of dummies by education level to control non-parametrically for education. Time fixed effects are at the year-quarter level. The sample consists of individuals who were unemployed in period $t-2$, and were not employed in period $t-1$. We run the regressions by weighted OLS. *, **, and ***, denote significance at the 10%, 5%, and 1% level.*

## D.3 Constrained agents transition more into self-employment

We now ask whether the transitions to self-employment we observe are consistent with the idea that individuals who are more resource-constrained are more likely to become self-employed. We focus on this mechanism for two main reasons. First, individuals who choose self-employment out of necessity do so based less on their own preferences for self-employment or entrepreneurial ability,[20] and more on the insurance properties of self-employment, producing a larger share of unproductive small enterprises and

[20] Hurst and Pugsley (2016) proposed non-pecuniary benefits from self-employment to explain the patterns of self-employment in the U.S. This taste for self-employment complements standard arguments for selection into self-employment based on own-perceptions (correct or not) of entrepreneurial ability, or other idiosyncratic traits like a low job-finding rate.

reducing aggregate productivity. Second, the decision to become self-employed out of necessity can be influenced by policy more directly than when the decision is dictated by the preferences or ability of the individual.

We use two variables to proxy for access to additional sources of income: the presence of a second earner in the household (as in Chetty (2008)), and the receipt of remittances from relatives living abroad. We compare transitions from unemployment for constrained and unconstrained individuals. Table D.5 show the results. Individuals with additional sources of income transit less into self-employment.[21]

Turning to the results in Table D.5a, we estimate that individuals in a household with a second earner have a 3.2 percentage point higher probability of transitioning to employment and a 3.9 percentage point lower probability of transitioning to self-employment (a 17 percent decrease, from 22.2 to 18.3 percent) than individuals without a second earner. We also test whether the individual's (self-reported) job search activity changes with the presence of a second earner (Table D.6). Most job-search activities (e.g., examining job postings, looking for a temporary job) are not significantly different for individuals with a second earner. Importantly, there is no difference in whether agents report being making plans to start their own business.

The same results are backed by the exercise using remittances as a proxy for the resources of the individual. Individuals who receive remittances in times of unemployment transition at a lower rate to self-employment (10.8 percent vs 18.8 percent, Table D.5b). We also check whether individuals receiving remittances differ on search activities or the intent to start a business. Receiving remittances is associated with a lower likelihood of using the internet to look for a job, and a lower likelihood of of searching for temporary employment; however, it is also associated with a higher likelihood of asking directly for a job (Table D.7). Of course, we cannot rule out other sources of bias as the receipt of remittances is not created by exogenous variation across individuals.

Finally, we repeat the exercise on the transition rates out of self-employment. We find that less-constrained individuals are more likely to transition out of self-employment. Self-employed agents are on average 2.4 percentage points more likely to transition to employment when they are able to rely on a second earner. Unlike less-constrained self-employed, those constrained cannot devote time/effort to search activities that facilitate the transition to a salaried job. We report these results in column 5 of Tables D.3 and D.4.

[21] The results can also be interpreted as indicating that preferences and ability are not the main drivers of the transition to self-employment. If they were, we should observe that people with external income sources transit more to self-employment, as they could enjoy the non-pecuniary benefits of work independence or try their luck at entrepreneurship, while not worrying (as much) about low income levels.

| | (1) U→E | (2) U→S | (3) U→U | (4) U→I |
|---|---|---|---|---|
| Second Earner | 0.032*** | -0.039** | 0.007 | -0.000 |
| | [0.010] | [0.018] | [0.015] | [0.000] |
| Age | -0.008*** | 0.003*** | 0.005*** | 0.000 |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Constant | 0.835*** | 0.209 | -0.044 | -0.001 |
| | [0.301] | [0.326] | [0.098] | [0.002] |
| Observations | 8376 | 8376 | 8376 | 8376 |
| Mean Dep. Variable | 0.505 | 0.222 | 0.272 | 0.000104 |
| Schooling Controls | Yes | Yes | Yes | Yes |
| Time Fixed Effect | Yes | Yes | Yes | Yes |
| Weighted | Yes | Yes | Yes | Yes |

(a) Second Earner and Transitions from Unemployment

| | (1) U→E | (2) U→S | (3) U→U | (4) U→I | (5) U→S |
|---|---|---|---|---|---|
| Remittances | 0.058 | -0.080*** | -0.033 | 0.055 | |
| | [0.053] | [0.021] | [0.040] | [0.037] | |
| Age | -0.012*** | 0.002*** | 0.002** | 0.008*** | 0.001*** |
| | [0.000] | [0.000] | [0.001] | [0.001] | [0.000] |
| Latent Remittances | | | | | -0.045 |
| | | | | | [0.036] |
| Constant | 1.237*** | 0.147 | -0.168*** | -0.216 | 0.177 |
| | [0.262] | [0.202] | [0.050] | [0.227] | [0.114] |
| Observations | 8615 | 8615 | 8615 | 8615 | 25135 |
| Mean Dep. Variable | 0.463 | 0.188 | 0.256 | 0.0932 | 0.188 |
| Schooling Controls | Yes | Yes | Yes | Yes | Yes |
| Time Fixed Effect | Yes | Yes | Yes | Yes | Yes |
| Weighted | Yes | Yes | Yes | Yes | Yes |

(b) Remittances and Transitions from Unemployment

Table D.5: Transitions from Unemployment

***Note:*** *In both panels, the LHS variable is an indicator variable that takes the value of one if the individual experienced the transition specified in each column. U denotes unemployment, E salaried work, S self-employment, and I inactivity. Second Earner is an indicator variable that takes the value of one if the individual's partner was an income earner in period $t-1$. Remittances is an indicator variable that takes the value of one if the individual reported having received remittances in period $t-1$. Latent Remittances is a dummy equal to one if we observe the individual to ever receive remittances. Standard errors are clustered at the city level. Schooling controls are a set of dummies by education level to control for education in a non parametric manner. Time fixed effects are at the year-quarter level. The sample consists of individuals who were unemployed in period $t-1$. The regressions are run by weighted OLS. *, **, and *** denote significance at the 10%, 5%, and 1% level.*

| | (1) Asked | (2) Job Post | (3) Public Ag | (4) Temp | (5) SE Plans | (6) Internet | (7) Newspaper | (8) Need to Work | (9) Age |
|---|---|---|---|---|---|---|---|---|---|
| Second Earner | -0.033 | -0.009 | -0.006 | -0.002 | 0.002 | -0.058*** | -0.022 | 0.000 | 1.564*** |
| | [0.023] | [0.010] | [0.008] | [0.003] | [0.001] | [0.019] | [0.017] | [0.000] | [0.528] |
| Constant | 0.203*** | 0.021** | 0.020** | 0.008*** | 0.001 | 0.105*** | 0.069*** | 0.000 | 41.063*** |
| | [0.022] | [0.009] | [0.008] | [0.002] | [0.001] | [0.018] | [0.016] | [.] | [0.497] |
| Observations | 11214 | 11214 | 11214 | 11214 | 11214 | 11214 | 11214 | 11214 | 11214 |

Table D.6: Second Earner and Job-Search Activities

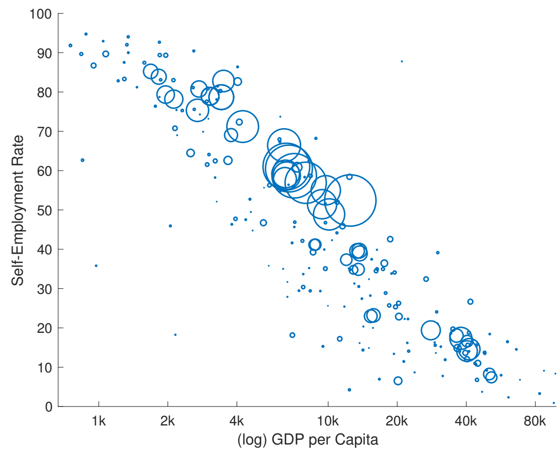
***Note:*** *The LHS variable is an indicator variable that takes the value of one if individual $i$ performed the given activity to search for a job in the previous quarter. The last two columns correspond to weather or not the individual declares to have a need to work, and differences in age. Second Earner is an indicator variable that takes the value of one if the individual's couple was an income earner in period $t-1$. Standard errors are clustered at the city level. All regressions include schooling controls (a set of dummies by education level to control non-parametrically for education), and time fixed effects at the year-quarter level. The sample consists of individuals who were unemployed in period $t-1$. The regressions are run by weighted OLS.* *, **, *and* ***, *denote significance at the 10%, 5%, and 1% level.*

| | (1) Asked | (2) Job Posting | (3) Public Ag. | (4) Temp | (5) SE Plans | (6) Internet | (7) Newspaper | (8) Need to Work | (9) Age |
|---|---|---|---|---|---|---|---|---|---|
| Remittances | 0.183* | 0.023 | 0.004 | -0.007*** | -0.004** | -0.035*** | 0.092 | 0.045 | -0.250 |
| | [0.103] | [0.023] | [0.012] | [0.002] | [0.002] | [0.004] | [0.089] | [0.051] | [2.385] |
| Constant | 0.157*** | 0.007*** | 0.008*** | 0.007*** | 0.004** | 0.035*** | 0.040*** | 0.043*** | 43.766*** |
| | [0.007] | [0.002] | [0.002] | [0.002] | [0.002] | [0.004] | [0.004] | [0.004] | [0.212] |
| Observations | 8200 | 8200 | 8200 | 8200 | 8200 | 8200 | 8200 | 8200 | 8200 |

Table D.7: Remittances and Job Search Activities

***Note:*** *The LHS variable is an indicator variable that takes the value of one if individual $i$ performed the given activity to search for a job in the previous quarter. The last two columns correspond to weather or not the individual declares to have a need to work, and differences in age. Remittances is an indicator variable that takes the value of one if the individual reported having received remittances in period $t-1$. Standard errors are clustered at the city level. All regressions include schooling controls (a set of dummies by education level to control non-parametrically for education), and time fixed effects at the year-quarter level. The sample consists of individuals who were unemployed in period $t-1$. The regressions are run by weighted OLS. *, **, and ***, denote significance at the 10%, 5%, and 1% level.*

Figure D.1: Self-Employment Rate Across Countries




***Note:*** *The figure shows self-employment rates for countries around the world, as a function of their GDP per capita. The size of each bubble illustrates the population size of each country. Data source: World Development Indicators of the World Bank.*

## D.4 Self-employment around the world

In this appendix we report additional results on the prevalence of self-employment around the world. As Figure D.1 shows, self-employment decreases consistently as countries' income rises. Moreover, self-employment tends to be concentrated in the bottom and top of the earnings distribution within each country. We reproduce the exercise behind Figure 1 with data from 10 countries around the world We first run a regression of the form $\log(earn_{i,t}) = \alpha + \gamma_t + \beta X_{i,t} + \eta_{i,t}$, where $earn_{i,t}$ corresponds to the earnings of individual $i$ at time $t$, and $X$ is a vector of individual-level controls. We rank $\hat{\eta}_{i,t}$ and classify them in bins of 2 percent of the sample, then compute the self-employment rate in each bins. In all cases we use harmonized household surveys.

Figure D.2 presents the results. The u-shape relationship between self-employment and earnings with a skewed presence in the bottom of the earnings distribution is common across countries, with the exception of Azerbaijan.

Finally, there is the concern that misreporting of income correlated with occupation is behind this pattern. To address this, we show in Figure D.3 that the same pattern of concentration at the bottom is present when comparing self-employment across the consumption distribution. Self-employment is concentrated among those who consume less.

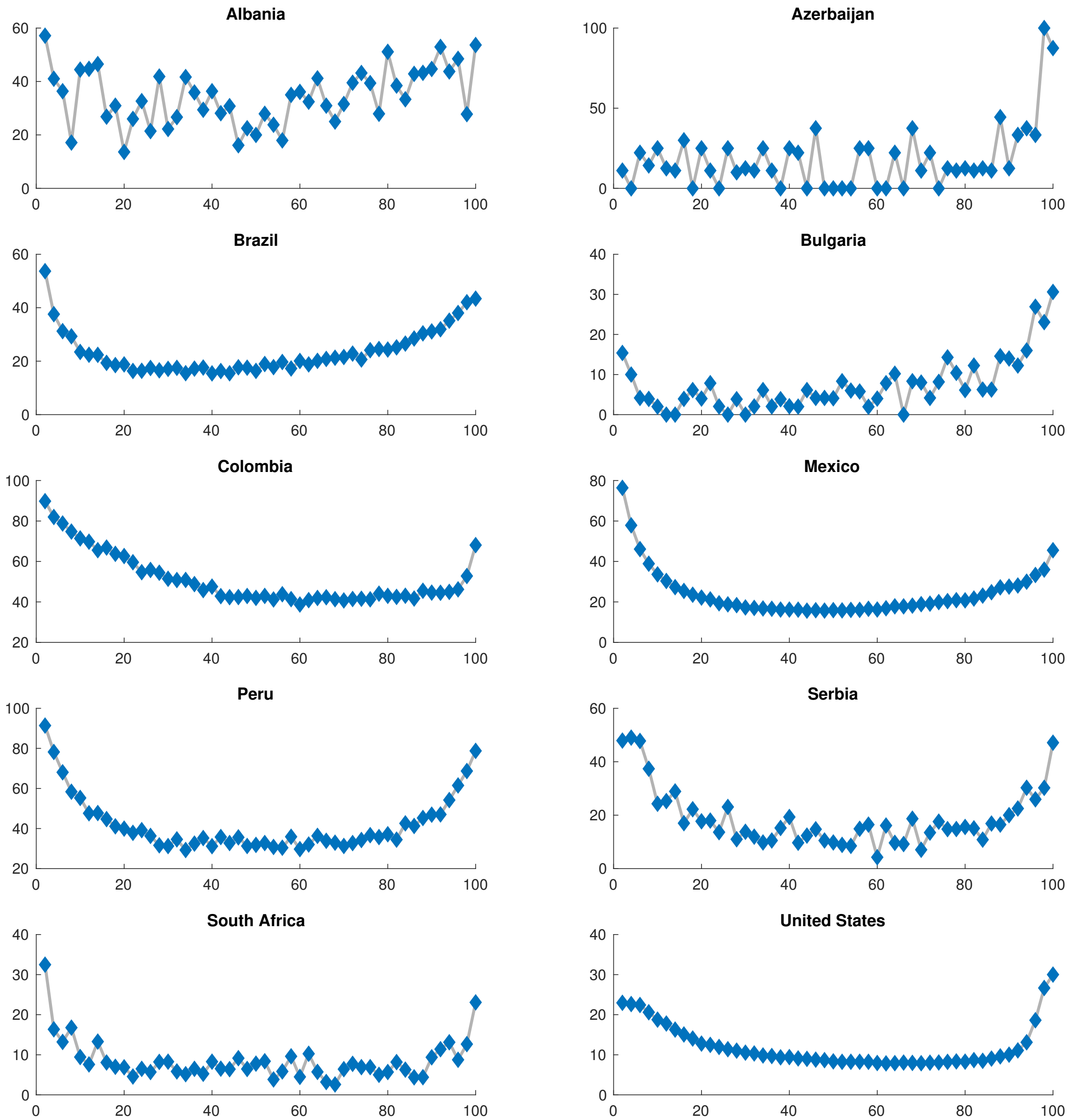
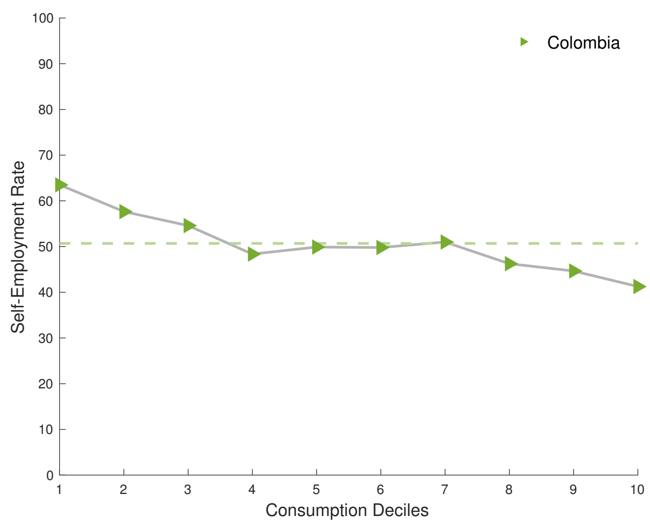



Figure D.2: Self-Employment and Earnings Across Countries

***Note:*** *The figure reports the share of the population classified as self-employed for bins of the earnings distribution for ten countries around the world. Each bin corresponds to two percent of the population. The horizontal dashed lines correspond to the average self-employment rate in each country.*

Figure D.3: SE by Consumption Distribution




***Note:*** *The figure reports the share of the population classified as self-employed for bins of the consumption distribution for Colombia. Each bin corresponds to ten percent of the population. The horizontal dashed lines correspond to the average self-employment rate.*