Entrepreneurs, Sudden Stops, and Inequality

Hanjo Terry Kim [1]

December 10, 2021

Link to the latest version

Abstract. This paper quantifies the importance of heterogeneity across entrepreneurs in accounting for aggregate and distributional dynamics during sudden stops. Using Argentinian household survey data from 1996 and 2003, I establish that the income distribution of entrepreneurs widened relative to that of workers. Motivated by this, I develop a small open-economy, heterogeneous-agent model with occupational choice in which households endogenously select into being a worker, a self-employed entrepreneur, and an employer entrepreneur. The model rationalizes aggregate and distributional features of sudden stops that standard models cannot. The model shows that a tax on assets and capital reduces the probability of a sudden stop, reduces long-run welfare, and dampens the relative widening of the income distributions by disincentivizing entrepreneurship.

Keywords: Sudden stops; Small open economy; Entrepreneurs; Financial crisis

JEL Codes: E32, E26, F41, F38

[1] Vanderbilt University. e-mail: terry.h.kim@vanderbilt.edu. Acknowledgements: I wish to sincerely thank Mario Crucini for his tireless support and advice while writing this paper. I am also deeply grateful to Malin Hu, Kevin Huang, Kathleen McKiernan, and David Parsley as well as the participants at seminars and conferences for invaluable comments and feedback. All errors are my own.

1 Introduction

Sudden stops, which are financial crises triggered by a sudden outflow of foreign capital, have large impacts on the income distribution through various dimensions. In this paper, I argue that entrepreneurship is an important determinant of the distributional impact during sudden stops. Using a sudden stop episode in Argentina as a case study, I empirically document that the income distribution of entrepreneurs widened relative to that of workers. To analyze this empirical finding, I develop a small open-economy model with heterogeneous agents that choose to either be a worker, a self-employed entrepreneur, or an employer entrepreneur. I find that distinguishing self-employed and employer entrepreneurs is crucial to account for the aggregate and distributional dynamics during sudden stops. A tax on assets and capital reduces the probability of a sudden stop, but it also reduces long-run welfare because a tax disincentivizes entrepreneurship. The policy also dampens the rise in the income distribution of entrepreneurs relative to that of workers.

My empirical work involves the income losses of entrepreneurs relative to those of workers to shed light on the distributional impact of sudden stops. Using individual-level survey data from Argentina between 1996 to 2003, when the country experienced a severe financial crisis, I find that being a poor entrepreneur is associated with a 20% higher average relative income loss compared to a poor worker during sudden stops. In contrast, being a rich entrepreneur is associated with a 15% lower average relative income loss compared to a rich worker. The heterogeneity in average relative income responses of entrepreneurs to workers can be explained by the existence of self-employed entrepreneurs and employer-entrepreneurs. Self-employed entrepreneurs operate a small establishment and are mostly found at the bottom end of the income distribution. They also make up the majority of the entrepreneurial group. The rest of the group is made up of employer-entrepreneurs who are mostly found at the top end of the income distribution, operate large establishments, and have a high income relative to workers and self-employed entrepreneurs. Together, these empirical facts imply the need to differentiate poor and rich entrepreneurs.

To evaluate the empirical evidence, I propose a heterogeneous-agent, small open-economy model where households select into being a worker, a self-employed entrepreneur, or an employer entrepreneur. The model does well in capturing severe drops in output, consumption, investment, and a rise in the trade balance-to-GDP ratio during sudden stops. In terms of the distributional impact, I find that the differentiation of self-employed and employer-entrepreneurs is crucial to capture the heterogeneity in relative income losses across the income distribution. Three key mechanisms drive the heterogeneous response. First, self-employed entrepreneurs face no barrier to entry while employer-entrepreneurs must pay a per-period fixed cost to operate. Second, self-employed entrepreneurs face a higher degree of financial friction. This theoretically affects the poor entrepreneur's income response at the extensive and the intensive margin by inducing a higher share of the population to be at the binding constraint and affecting their choice of capital demand. Third, employers and self-employed entrepreneurs differ in their labor inputs. In the model, the inability to hire external labor for self-employed entrepreneurs implies that any reduction in the labor input will strictly lead to a decline in income. On the other hand, employer-entrepreneur's ability to hire external labor implies that when real wages decline in response to a negative productivity shock, it helps mitigate the overall fall in income. These results highlight how the modeling of occupational heterogeneity helps account for the impact on the aggregate and the income distribution dynamics.

Finally, I quantify how a capital tax affect the probability of a crisis, long-run welfare, and aggregate as well as distributional dynamics during sudden stops. I find that a flat tax on the rental rate of capital and the returns to savings disincentivizes entrepreneurship and stabilizes external balance flows. Quantitatively, the crisis probability falls from 4.3% to 1.7%. However, the policy hurts aggregate welfare and output in the stationary equilibrium because there are fewer wealthy entrepreneurs. These results suggest that capital controls induce a trade-off between financial stability and the long-run economy. Outside the stationary equilibrium, the population distribution dynamics change in response to aggregate shocks, which in turn affect the aggregate dynamics during sudden stops. In particular, I find that a tax dampens the consumption and trade balance responses while amplifying the investment response. Furthermore, a tax changes the distributional impact by reducing the increase in income inequality among entrepreneurs relative to that among workers.

This paper contributes to three strands of the literature. First, I contribute to the entrepreneurship literature, which studies how entrepreneurs shape the wealth and income inequality in the United States.[2] There are also seminal papers on entrepreneurs in small open-economy settings.[3] In emerging markets, self-employment is very prevalent and makes up the majority of the entrepreneurial group. Allub and Erosa (2019) includes a model of self-employment into an otherwise standard entrepreneurship model. As emphasized in this paper, they also find that a large fraction of self-employed entrepreneurs is necessary to adequately model occupational dynamics in developing countries. Anchorena and Ronconi (2012) and Casalí et al. (2017) show that self-employment is a good proxy for the informal sector. Granda and Hamann (2015) and Lopez-Martin (2018) develop an entrepreneurship model with an informal sector. Building on this literature, I introduce aggregate shocks to study the role of entrepreneurs on the income distribution during sudden stops.

Second, I contribute to the literature on sudden stops. Seminal works such as Mendoza (2010), Korinek and Sandri (2016), and Bianchi (2011) focus on the aggregate impacts. My paper builds on this literature and also focuses on distributional effects. There has been some recent work on finding distributional impact during sudden stops.[4] My paper contributes to this strand of literature by arguing that the heterogeneity of entrepreneurs is an important driver of inequality during sudden stops.

Finally, this paper is related to a growing body of literature that embeds heterogeneous-agent into a small open-economy real business cycle framework. Hong (2020) develops a heterogeneous-agent model with several idiosyncratic and aggregate shocks, but with the focus on explaining the consumption volatility puzzle in emerging markets. Unlike the paper, I focus on sudden stops and the heterogeneity of occupations.

The outline of the paper is as follows: Section 2 presents the empirical results. Section 3 presents a baseline model of occupational choice with heterogeneous agents in a small open-economy setting. Section 4 presents the calibration. Section 5 discusses the model's ability to match the population distribution in the stationary equilibrium and aggregate as well as

[2]See Cagetti and De Nardi (2006) and Quadrini (2000). Kwark and Ma (2020) is also relevant because they include aggregate shocks and explore the acyclicality of the top income earners.

[3]See Buera et al. (2015) and Buera et al. (2011).

[4]de Ferra et al. (2019) and Villalvazo (2020) explores distributional implications with a focus on asset price channels and wealth heterogeneity. Cugat (2019) develops a two-sector Two Agent New Keynesian (TANK) model to explore the distributional impact through sectoral heterogeneity. Liu et al. (2020) study how the capital account policy can affect the income distribution between entrepreneurs and workers.

distributional dynamics during sudden stops. Section 6 presents the impact of a capital tax in my baseline economy. Section 7 concludes.

2 Empirical Evidence on the Role of Occupational Heterogeneity During Sudden Stops

In this section, I document the heterogeneity in income responses to aggregate shocks across occupations and the income distribution. First, I establish that the income distribution among entrepreneurs is more unequal than the income distribution amon workers. This is driven by the fact that self-employed entrepreneurs constitute the majority of entrepreneurs and exhibit lower average incomes than the other groups, while employer-entrepreneurs make up the rest of the entrepreneurial group and exhibit average income levels that are high relative to those of the rest of the population. Second, I find that poor entrepreneurs are associated with average income losses that are higher than those of poor workers, but rich entrepreneurs are associated with lower average income losses than those of rich workers. These empirical findings motivate me to include both types of entrepreneurship in the baseline model in accounting for the distributional impact of sudden stops.

2.1 Data Description

I use data from the Permanent Household Survey conducted by the National Institute of Statistics and Censuses (INDEC) of Argentina for the empirical analysis for two reasons. First, the survey reports detailed statistics on income, employment, and income sources, which are used to classify individuals into the different occupational groups. Second, the survey covers a period during which Argentina experienced a series of sudden stops. Between 1998 and 2001, real GDP declined by 15%, the current account-to-GDP ratio rose by more than 10 percentage points, and the income Gini index rose by more than 4 points.[5]

The survey is conducted twice a year and reports information on individual characteristics related to employment, sectors, housing, and income. The survey also asks how much of an

[5]Source: World Development Indicators (WDI).

Table 1: Summary Statistics

	Workers	Entrepreneurs	Self-Employed	Employer
Income Share	72	27	16	11
Population Share	75	24	20	4
Income Share/Population Share	0.9	1.1	0.8	2.4
Mean	564	638	469	1305
Median	421	364	311	866
P20	242	160	143	364
P80	737	871	643	1930
Gini	0.42	0.55	0.50	0.49

Note: These are time averaged statistics from 1996-2003. The first two rows are in percentages, P20 and P80 imply 20th and 80th percentiles. Mean, median, P20, and P80 utilize income in the reference month and are listed in Argentinian pesos.

individual's total income comes from earned and unearned income sources. Earned income sources are further broken down into the following categories: earnings as an employee, from self-employed activities, or as an employer. Unearned income sources include payments from unemployment insurance, earnings from rent, contributions from family members, or interest rate payments from stocks and bonds. I focus on earned income sources because earned income makes up the majority of an individual's income. Given an individual's income level as well as income sources, I can categorize the individuals as either a worker, a self-employed entrepreneur or an employer-entrepreneur by taking the maximum of the three potential income sources. For example, if an individual's largest income source is from earnings as an employee, then that individual is characterized as a worker. If an individual's largest income source comes from running their own businesses (either from self-employed activities or from employer earnings), then that individual is characterized as an entrepreneur. The entrepreneur category is further broken down into either self-employed entrepreneurs or employer-entrepreneurs depending on their source of business income.

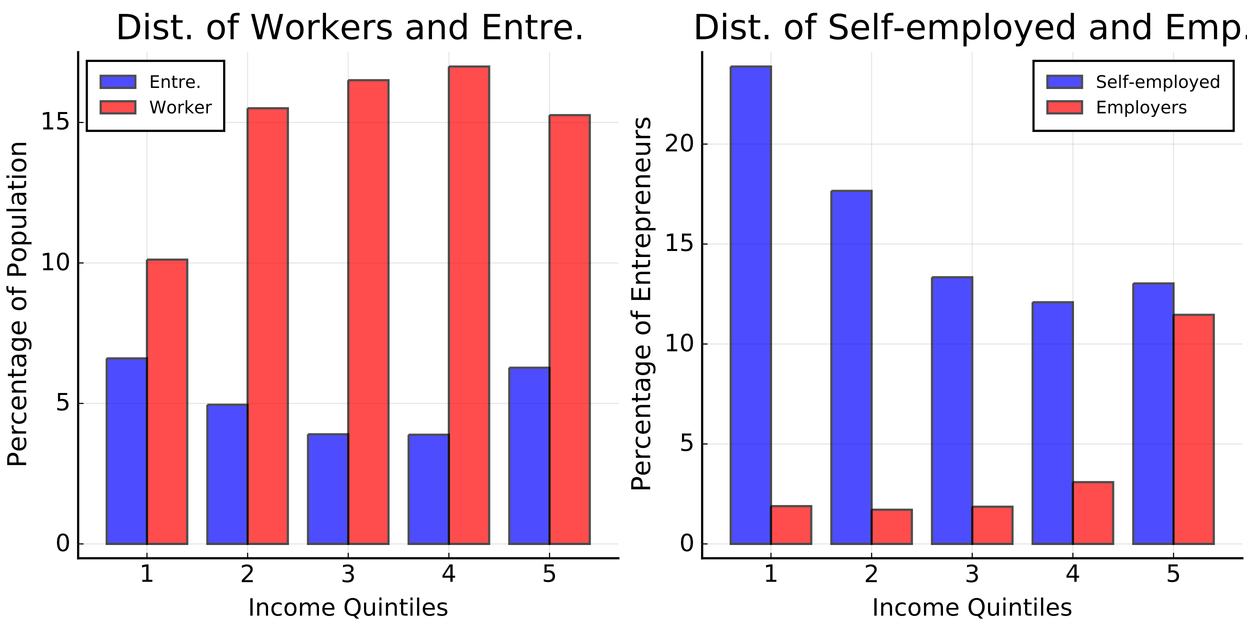
2.2 Summary Statistics on Incomes across Occupations

Table 1 presents summary statistics on the income distribution with these occupational classifications in mind. The first two columns report statistics related to workers and entrepreneurs. Workers make up 75% of the population, while entrepreneurs make up the remainder. These population shares match up reasonably closely to the income shares: 72% and 28%, respectively. I also report the ratio of the income share to the population share to provide a sense of the income concentration per group. This measure is 0.96 for workers and 1.12 for entrepreneurs, implying that income is more concentrated within the entrepreneurial group. I also report the mean, median, 20th percentile, 80th percentile, and Gini index. The mean is higher than the median for both groups, which implies that the income distributions of both workers and entrepreneurs are right-skewed. However, the income distribution of entrepreneurs is skewed more heavily than the income distribution of workers.

The standard entrepreneurship literature focuses on advanced economies and emphasizes the role of rich entrepreneurs in explaining income and wealth inequality. However, in emerging economies such as Argentina, self-employment is prevalent. Therefore, the table further categorizes entrepreneurs as either self-employed entrepreneurs or as employer-entrepreneurs. Self-employed entrepreneurs account for 16% of the total income in the economy, but make up 20% of the population. Employer entrepreneurs make up only 5% of the population but are responsible for 11% of the total income in the economy. Furthermore, the average income level of an employer-entrepreneur is three times higher than that of a self-employed entrepreneur. These indicate large and systematic differences between the two types of entrepreneurs.

The left-hand panel of Figure 1 plots the population distribution of workers and entrepreneurs across the income distribution, while the right-hand panel does the same for self-employed and employer entrepreneurs. Focusing on the left panel, two features are noteworthy. First, there are more workers than entrepreneurs at each point of the income distribution, which is consistent with the aggregate level statistics. Second, the distribution of entrepreneurs exhibits bimodality. In the bottom income quintile, 6.6% of individuals are entrepreneurs, while 10.1% of all individuals are workers. The share of entrepreneurs declines as individuals move up the income distribution until they reach the top income quintile. Then, the share of entrepreneurs starts to rise again. The top of the distribution is quite consistent with the income distribution in the United States, which shows that the top tail of the income and wealth distribution can be explained well by the existence of entrepreneurs. By contrast, entrepreneurs constitute a large share of households in the lower

Figure 1: Population Distribution



Note: The graph in the left panel shows the distribution of workers and entrepreneurs within the population by income quintiles. There are many entrepreneurs in the bottom quintile and the top quintile. The graph in the right panel shows which type of entrepreneurs are in each income quintile. Most entrepreneurs are self-employed, but entrepreneurs at the top are employer-entrepreneurs. These are time-averaged statistics from 1996-2003.

end of the income distribution in Argentina.

The right panel shows that the entrepreneurs in the top and the bottom quintiles differ. Approximately 24% of all entrepreneurs are in the bottom quintile of the income distribution and are self-employed. This share of self-employed entrepreneurs is mostly decreasing in income quintiles. In the top income quintile, there are more employer-entrepreneurs than self-employed entrepreneurs. This emphasizes the point that there are systematic differences in terms of background and quality in the types of entrepreneurship along the income distribution.

2.3 Heterogeneous Income Losses from Sudden Stops

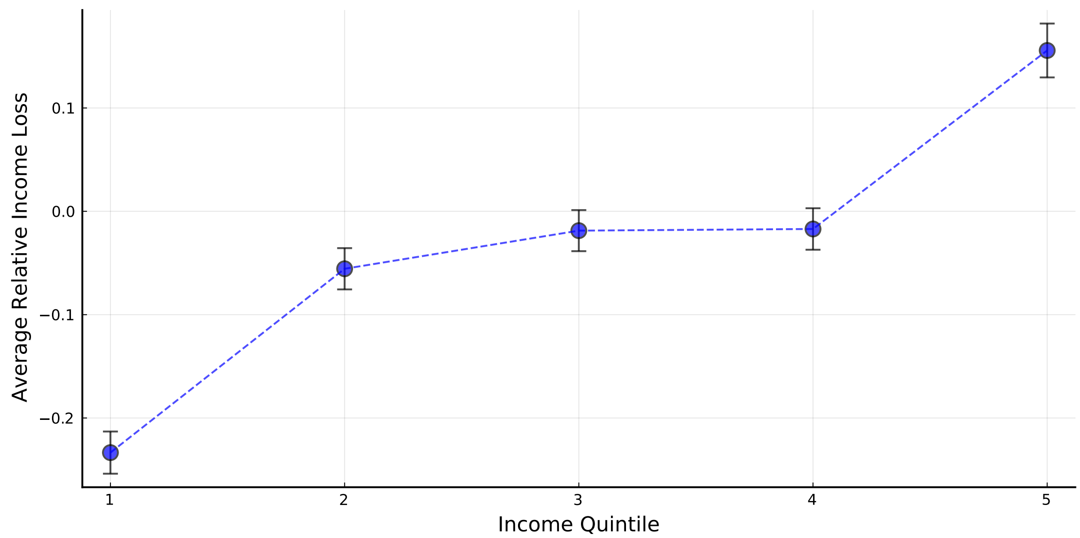
I now explore the role of entrepreneurship in explaining the rise in income inequality during a sudden stop using a difference-in-differences framework. Specifically, I estimate the effect of a sudden stop on the income of entrepreneurs across the income distribution relative to that of workers. The regression equation is:

$$\begin{aligned}\ln y_{it} = \lambda_t + Entre_{it} + \beta Crisis_t Entre_{it} + \sum_{k=2}^{5} \mu_k \mathbb{1}\{i \text{ s.t. } y_{it} \in k\text{-th quintile}\} \\ + \sum_{k=2}^{5} \phi_k Crisis_t Entre_{it} \mathbb{1}\{i \text{ s.t. } y_{it} \in k\text{-th quintile}\} + \Gamma X_{it} + \epsilon_{it},\end{aligned} \tag{1}$$

where $\ln y_{it}$ is the log income of individual i at time t, λ_t is a time fixed effect, $Entre_{it}$ is a dummy variable that is equal to 1 when individual i is classified as an entrepreneur at time t, and $Crisis_t$ is a dummy variable that equals 1 when the time period corresponds to a sudden stop episode, which in this case will be after October of 1998. I also include a vector of controls, denoted by X_{it}, which include factors such as the sector of occupation, family status (whether one is the head of a household or not), gender, age, location, and education level.

The term $\sum_{k=2}^{5} \phi_k Crisis_t Entre_i \mathbb{1}\{i \text{ s.t. } y_{it} \in k\text{-th quintile}\}$ allows the effect of the sudden stop on the entrepreneurs' income to vary flexibly across the income distribution. In this specification, the interpretation of β is the average loss in income of an entrepreneur relative to a worker in the first income quintile, and $\beta + \phi_k$ would represent the average impact of a crisis on income for an entrepreneur relative to a worker in the k-th quintile. Thus, the

Figure 2: Heterogeneity in Income Loss from Sudden Stops - Between Occupations and across the Income Distribution



Note: This plot shows the heterogeneous effects a sudden stop by occupation and across income quintiles. In the y-axis, I plot the average relative income loss $\{\beta, \beta+\phi_2, ..., \beta+\phi_5\}$ between the two occupation groups β represents the average relative income loss between two occupation groups in the first quintile, and $\beta+\phi_k$ present the average relative income loss in a k-th quintile. The horizontal axis displays income quintiles. The vertical axis displays the coefficient of interest, which is $\beta+\phi_k$ for k-th quintile, except for the first income quintile, which is β. The 95% confidence intervals are also plotted along with the estimated coefficients.

main coefficients of interest are the elements of the vector $\{\beta, \beta+\phi_2, ..., \beta+\phi_5\}$.

Figure 2 plots these coefficients and their standard errors. The key takeaway is that entrepreneurs are associated with higher relative income loss on average compared to workers in the bottom 80% of the income distribution, where the relative average income loss is most pronounced in the bottom quintile. However, entrepreneurs are associated with lower relative income loss on average compared to workers in the top income quintile. These estimates imply that entrepreneurs' income distribution widens relative to that of worker's during sudden stops and that this is largely driven by the movements in the bottom and the top quintile. As shown in Section 2.2, the majority of entrepreneurs in the bottom income quintiles is self-employed, while the majority of entrepreneurs in the top income quintile is employers. These results imply that accounting for two types of entrepreneurship, self-employed and employer, is crucial to capture this heterogeneity in average relative income responses. I now turn to a baseline model that incorporates this feature.

3 Baseline Model

The baseline model embeds an entrepreneurship choice from the macro-development literature (Buera et al. (2015), Midrigan and Xu (2014)) into an otherwise a standard small open-economy model (Mendoza (1994), Aguiar and Gopinath (2007), García-Cicco et al. (2010)). The number of infinitely lived households is normalized to 1, and they are heterogeneous in their wealth, entrepreneurial ability, and worker productivity.[6]

At the beginning of each period, individuals with an asset level a observe their productivity as a worker and their ability as an entrepreneur. Afterward, they choose to be a worker with a labor income of $w\bar{h}^w\epsilon$, a self-employed entrepreneur with a profit of π^{se}, or an employer-entrepreneur with a profit of π^{em}. The rest of the model follows the standard small open-economy real business cycle literature, in which a representative corporate firm produces final goods by using labor and capital. There is also a capital goods-producing firm that produces capital goods and lends them to the corporate firm and to entrepreneurs. The rest of the world provides risk-free bonds to households and firms alike. Aggregate dynamics in this economy are driven by two aggregate shocks, the aggregate productivity, denoted by z, and the interest rate premium, denoted by μ.

3.1 Preferences

Individuals maximize expected utility of the form

$$U(c_t, h_t) = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_t, h_t)\right],$$

where the flow utility is given by

$$u(c_t, h_t) = \frac{c_t^{1-\gamma}}{1-\gamma} - \frac{h_t^{1+1/\psi}}{1+1/\psi}.$$

Here, γ is the coefficient of relative risk aversion, β is the discount factor, and ψ is the Frisch elasticity of the labor supply. Workers supply $\bar{h}^w$ hours inelastically to the labor market each period.

[6]as in Aiyagari (1994) and Huggett (1992).

3.2 Technology

At the beginning of each period, the households differ in their level of liquid assets, a_t, productivity as a worker, ϵ_t, and entrepreneurial ability, θ_t. The household's level of saving is subject to an ad hoc borrowing constraint, a_{min}. The random variables, ϵ_t and θ_t are independent of each other and follow an N-state Markov chain that can take on values $\epsilon_t \in \{\epsilon_1, ..., \epsilon_N\}$ and $\theta_t \in \{\theta_1, ..., \theta_M\}$, respectively, with transition probabilities characterized by $p_\epsilon(\epsilon_{t+1}|\epsilon_t)$ and $p_\theta(\theta_{t+1}|\theta_t)$.

I assume that there is only one sector in the model. This implies that self-employed and employer entrepreneurs produce an identical numeraire good. This can be rationalized by the existence of an informal sector, which is proxied by self-employment. One can think about entrepreneurial activities as ranging from selling handmade carpets on the street to a formal carpet business with several hundred employees and factories with a large retail network.

Self-employed entrepreneurs

Self-employed entrepreneurs operate a decreasing returns to scale technology to produce output y_t^{se} using capital k_t and own labor h_t according to

$$y_t^{se} = z_t \theta_t \xi (k_t^\alpha h_t^{1-\alpha})^{\nu^{se}},$$

where ν^{se} is the span-of-control parameter as in Lucas (1978) for the self-employed, z_t is the aggregate productivity shock, α is the capital share, and ξ is the parameter that controls the relative productivity between an employer and a self-employed entrepreneur. The profit function is

$$\pi_t^{se}(k_t, h_t; u_t, w_t, z_t) = \max_{k_t, h_t} \; z_t \theta_t \xi (k_t^\alpha h_t^{1-\alpha})^{\nu^{se}} - (u_t + m) k_t,$$

where $u_t + m$ is the rental cost of capital. u_t is the rental cost that is common across all businesses (corporate, employers, and self-employed alike), while $m > 0$ is the parameter that represents the additional cost to borrow capital faced by self-employed entrepreneurs.

Employer entrepreneurs

Employer entrepreneurs similarly operate a decreasing returns to scale technology that produces output y_t^{em} using capital k_t and external labor l_t according to

$$y_t^{em} = z_t \theta_t (k_t^{\alpha} l_t^{1-\alpha})^{\nu^{em}},$$

The employer-entrepreneur's profit, after taking into account the fixed cost of operation denoted by $(1+r_t)\kappa$, can be written as

$$\pi_t^{em}(k_t, l_t; u_t, w_t, z_t) = \max_{k_t, l_t} \; z_t \theta_t (k_t^{\alpha} l_t^{1-\alpha})^{\nu^{em}} - u_t k_t - w_t l_t - (1+r_t)\kappa,$$

where u_t is the rental rate of capital, and w_t is the wage rate.

Last, following Cagetti and De Nardi (2006), both types of entrepreneurs face a collateral constraint of the form

$$k_t \leq \phi_i a_t, \quad i = se, em$$

where a_t is the level of assets held by a household and ϕ_i is the degree of credit market imperfection for an entrepreneur of type i. When the credit market is perfect, $\phi_i \to \infty$, which implies that the static labor and capital demand functions do not depend on the level of household wealth. $\phi_i = 1$ implies a strict credit market imperfection such that the entrepreneurial capital stock must be entirely financed by the household's wealth, which is assumed to be the case for self-employed entrepreneurs.

There are four main differences between the two types of entrepreneurship. First, there is the difference in productivity given by ξ. Second, self-employed entrepreneurs face a higher degree of financial frictions as seen by their higher cost of borrowing capital, given by m, and their tighter collateral constraint, given by ϕ_{se}. Third, employer-entrepreneurs pay a per-period fixed cost of $(1+r_t)\kappa$. Since the interest rate in this economy is countercyclical, the per-period fixed cost is also higher during recessions. Last, self-employed entrepreneurs are not able to hire external labor.

Corporate and Capital Goods Sector

The representative corporate sector firm behaves in a perfectly competitive manner and their production function is a standard Cobb-Douglas function that exhibits constant returns to scale

$$y_t^c = z_t (k_t^c)^{\alpha} (l_t^c)^{1-\alpha}.$$

Their profit function is therefore:

$$\pi_t^c(k_t^c, l_t^c; u_t, w_t, z_t) = \max_{k_t^c, l_t^c} z_t(k_t^c)^\alpha (l_t^c)^{1-\alpha} - w_t l_t^c - u_t k_t^c.$$

The representative capital goods producer also behaves in a perfectly competitive manner, produces investment goods, and rents capital to corporate firms and entrepreneurs. Its optimization problem can be described as follows

$$\pi^k = \max_{k_{t+1}^a} \left(\frac{1}{1+r_t}\right)^t \left(u_t k_t^a - i_t - \frac{\phi_k}{2}\left(\frac{k_{t+1}^a}{k_t^a} - 1\right)^2\right)$$
$$\text{subject to } i_t = k_{t+1}^a - (1-\delta)k_t^a$$

where ϕ_k denotes the adjustment cost of investment and i_t denotes investment, which follows a standard law of motion $i_t = k_{t+1}^a - (1-\delta)k_t^a$. The aggregate supply of capital at time t, denoted by k_t^a can be described by the following equation:

$$\left(1 + \phi_k\left(\frac{k_{t+1}^a}{k_t^a} - 1\right)\right) = \frac{1}{1+r_t}\left(u_{t+1} + 1 - \delta + \phi_k\left(\frac{k_{t+2}^a}{k_{t+1}^a} - 1\right)\frac{k_{t+2}^a}{k_{t+1}^a} - \frac{\phi_k}{2}\left(\frac{k_{t+2}^a}{k_{t+1}^a} - 1\right)^2\right) \tag{2}$$

3.3 Aggregate Shocks

The model features aggregate productivity and interest rate shocks denoted by z_t and μ_t, respectively. They both follow an AR(1) process in logs as given by

$$\log(z_{t+1}) = \rho_z \log(z_t) + \sigma_z \epsilon_{t+1}^z$$

$$\log(\mu_{t+1}) = \rho_\mu \log(\mu_t) + \sigma_\mu \epsilon_{t+1}^\mu.$$

where ϵ_{t+1}^z and ϵ_{t+1}^μ are i.i.d. random normval variables. ρ_z and ρ_μ represent the persistence of those shocks, while σ_z and σ_μ denote their standard deviations.

3.4 Closing the Model

To guarantee the stationarity of the model in aggregate dynamics, I impose a debt-elastic interest rate rule as in Schmitt-Grohé and Uribe (2003),

$$r_t = r^* + \omega(\exp(-(b_{t+1} - \bar{b})) - 1) + \exp(\mu_t) - 1 + \eta(y_{t+1} - \bar{y}), \tag{3}$$

where ω represents the elasticity of the interest rate with respect to debt and r^* is the world interest rate in the stationary equilibrium. $\bar{b}$ and $\bar{y}$ denote external debt and output in the steady state. $\eta < 0$ is the parameter that governs how the interest rate shock depends on the other fundamentals of the economy, typically to address the fact that interest rates rise in response to a decline in output. The channel that captures the increase in the interest rate premium is important when capturing the countercyclicality of external balances in the aggregate. The following functional form gives me tractability so that the model can be log linearized with respect to aggregate shock as in Reiter (2009).

Finally, markets for capital, assets, labor, and goods must clear.

$$\begin{aligned} k_t^a &= \int_{o=em,se} k_t d\Lambda_t + k_t^c \\ b_t &= \int a_t d\Lambda_t - k_t^a \\ \int_{o=w} h_t d\Lambda_t &= \int_{o=em} l_t d\Lambda_t + l_t^c \\ \int c_t d\Lambda_t + k_{t+1}^a + b_{t+1} &= y_t^a + (1 + r_t)b_t + (1 - \delta)k_t^a \end{aligned}$$

where $y_t^a = \int_{o=se} z_t\theta_t\xi(k_t^\alpha h_t^{1-\alpha})^\nu d\Lambda_t + \int_{o=em} z_t\theta_t(k_t^\alpha l_t^{1-\alpha})^\nu d\Lambda_t + y_t^c$, and the terms on the right hand side are the outputs from self-employed entrepreneurs, employer-entrepreneurs, and corporate sector, respectively. The first equation states that the total capital supply must equal the total capital demanded by the corporate firm and the employer-entrepreneurs. The second equation tells us that the net foreign asset position of the economy b_t is the difference between the total savings and the total capital stock in the economy. The rest of the world is able to elastically supply bonds to the small open-economy to clear the asset market. If domestic savings are less (more) than domestic investment, then b_t is negative (positive), which implies a capital inflow (outflow). The third equation states that the total labor supply from workers is equal to the total labor demanded by employer-entrepreneurs and corporate firms. By aggregating the budget constraints of the households and combining the other market clearing conditions, one can arrive at the goods market clearing codition.[7]

3.5 Recursive Representation of the Individuals' Problem

I now formulate the household problem in a recursive manner. At the beginning of each period, household's idiosyncratic state variables are denoted by $s = (a, \epsilon, \theta)$. Let $\Lambda(a, \epsilon, \theta)$ be the joint distribution over the idiosyncratic state variables implied by the decision rules of households. Then the aggregate state space is described by $S = (\Lambda, z, \mu)$.

At the beginning of each period, households choose their occupation by taking the maximum of three respective value functions,

$$v(s, S) = \max_{o \in \{w, se, em\}} \{v^w(s, S), v^{se}(s, S), v^{em}(s, S)\}. \tag{4}$$

If a household is a worker, then their value function is given by

$$v^w(s, S) = \max_{c, a'} \{u(c, \bar{h}^w) + \beta \mathbb{E}[v(s', S')]\}$$

subject to

$$\begin{aligned} c + a' &= y^w + a \\ y^w &= w \bar{h}^w \epsilon + ra \\ a' &\geq a_{\min} \\ \Lambda' &= G(\Lambda), \end{aligned}$$

where G is the law of motion for the joint distribution of households and v^w is the value function associated with being a worker. y^w is the income of a worker and is the sum of labor income and capital income.

[7] While there is a government sector that receives revenue from taxing employer-entrepreneurs' profits, it has been left out for simplicity because the government throws away the revenue.

Self-employed entrepreneur's value function is

$$v^{se}(s,S) = \max_{c,a'}\{u(c,h) + \beta\mathbb{E}[v(s',S')]\}$$

subject to

$$\begin{aligned}
c + a' &= y^{se} + a \\
y^{se} &= \pi^{se} + ra \\
\pi^{se} &= \max_{k,h} z\theta_t\xi(k^{\alpha}h^{1-\alpha})^{\nu^{se}} - (u+m)k \\
a' &\geq a_{\min} \quad k \leq \phi_{se}a \\
\Lambda' &= G(\Lambda),
\end{aligned}$$

where π^{se} is the profit from a self-employed entrepreneurial activities.

Employer entrepreneur's value function can be described by

$$v^{em}(s,S) = \max_{c^e,a'}\{u(c,0) + \beta\mathbb{E}[v(s',S')]\}$$

subject to

$$\begin{aligned}
c + a' &= y^{em} + a \\
y^{em} &= (1-\tau^{\pi})\pi^{em} + ra \\
\pi^{em} &= \max_{k,l} z\theta(k^{\alpha}l^{1-\alpha})^{\nu} - uk - wl - (1+r)\kappa \\
a' &\geq 0, \quad k \leq \phi_{em}a \\
\Lambda' &= G(\Lambda),
\end{aligned}$$

Employer entrepreneur's profit is given by the per-period profit minus the fixed cost $(1+r)\kappa$, capital cost uk, and labor cost wl. Their capital choices are also constrained at the rate ϕ_{em} and l is the amount of labor demanded by employer-entrepreneurs. Finally, τ^{π} is the profit tax for employer entrepreneurs.

3.6 Recursive Competitive Equilibrium

A recursive competitive equilibrium for this economy is given by a set of pricing functions $\{w_t(S), u_t(S), r_t(S)\}$, corporate capital and labor decisions $\{k_t^c(S), l_t^c(S)\}$, capital producer's decisions $k_t^a(S)$, households' policy functions $\{c_t^w(s,S), c_t^{se}(s,S), c_t^{em}(s,S), a_{t+1}^w(s,S), a_{t+1}^{se}(s,S),$ $a_{t+1}^{em}(s,S), h_t^{se}(s,S), l_t^{em}(s,S), k_t^{se}(s,S), k_t^{em}(s,S), o_t(s,S)\}$, value functions $\{v_t^w(s,S), v_t^{se}(s,S),$ $v_t^{em}(s,S)\}$, aggregate shocks $\{z_t, \mu_t\}$ and a law of motion G such that the following conditions hold:

1. Households maximize their value functions by choosing policy functions and their choices of occupations given prices;

2. Corporate firms and capital producing firms maximize profit by choosing capital and labor given prices;

3. Labor market, asset market, and goods market clear;

4. Aggregate law of motion is generated by savings decisions by households.

4 Calibration

To evalute the aggregate and distributional impacts during sudden stops using the model, I must ensure that the model parameterization is reasonable for the quantitative exercises. The goal of the calibration is to target key aggregate occupational-level statistics such as population shares and relative average incomes. I calibrate the model in two steps. First, I externally calibrate a subset of parameters that is consistent with the literature. Second, I internally calibrate the rest of the parameters to match several key moments in the data.
External Calibration Table 2 presents values that are externally calibrated. Two parameters that are fixed are related to preferences. The risk aversion parameter is set to a value of 2, which is a standard value used in the literature. Frisch elasticity of labor supply is set to 0.66, also in line with the macroeconomic literature. Four parameters are related to the production side of the economy. I assume that the capital share is the same across all production functions and set it to 0.33. Furthermore, I assume that self-employed entrepreneurs are not able to borrow externally and are only able to finance their entrepreneurial projects with their own assets. This implies that the parameter related to the collateral constraint is 1. Self-employed entrepreneurs also face a higher cost of borrowing capital, given by m. This

Table 2: **Externally Calibrated Parameters**

Parameter	Description	Value
Preferences		
γ	Risk aversion	2
ψ	Frisch elasticity of labor supply	0.66
Production		
α	Capital share	0.33
ϕ^s	Self-employed collateral constraint	1.00
m	Rental rate premium	0.13
τ	Profit tax rate	0.17
Aggregate Parameters		
r^*	World interest rate	0.02
ω^r	Elasticity of interest rate to debt	0.0001
ρ_μ	Persistence of interest rate	0.86
σ_μ	Standard deviation of interest rate	0.0003

is set to 0.13 in accordance with Granda and Hamann (2015), who find that self=employed entrepreneurs pay 2.3 times more to borrow capital compared to employer entrepreneurs. The profit tax rate set to 0.17, which is one of the main tax rates that employers pay in terms of social security contributions in Argentina. The world interest rate is set to 0.02, which is a standard value used in the literature. Finally, the last set of fixed parameters include the elasticity of interest rate to debt and output as well as two parameters that relate to the aggregate interest rate shock. The elasticity of interest rate to debt is set to a low value so that it plays a minimal role in the equilibrium dynamics. The persistence and the standard deviation of interest rate shock are set to 0.86 and 0.0003, respectively, which are taken from Schmitt-Grohé and Uribe (2016).

Internal Calibration I choose the parameters in Table 3 to match various empirical moments in the data, which are reported in Table 4.[8] The first set of moments relate to the preference. The discount factor, β, is set to match the capital-to-output ratio in the steady state. The labor supply for workers is inelastic by assumption and is set to match the population share of workers. Five parameters relate to the production side of the model. The span of control for self-employed entrepreneurs is set to match the income share of all self-employed entrepreneurs. The span of control for employer-entrepreneurs is set to match

[8]All the empirical moments that I target are time-averaged statistics.

the top 10% of employer-entrepreneurs' income share. The parameter that relates to the collateral constraint for employer-entrepreneurs is set to match the aggregate debt-to-GDP ratio in the steady state. The fixed cost of production for employer-entrepreneurs is set to match the total population share of employer-entrepreneurs. The relative productivity difference between a self-employed and employer entrepreneur is set to match the ratio of the average income of entrepreneurs over the average income of workers.

Each idiosyncratic shocks have two parameters that must be targeted. The persistence of the worker productivity is used to match the bottom 40% income share of workers, and the persistence of the entrepreneurial ability is used to match the bottom 40% income share of entrepreneurs. Similarly, the standard deviations of each respective shock are used to match the income Gini of its respective occupational group. Finally, there are three parameters that only affect the equilibrium dynamics outside the steady state. The adjustment cost of capital is used to match the relative volatility of investment to output. The persistence and the standard deviation of the aggregate TFP shock are used to match the persistence and the volatility of the aggregate output.

Table 4 shows the results of the internally calibrated parameters. Overall, the model does well in capturing various group-level as well as aggregate statistics. For example, the model is able to capture the NFA-to-GDP and the capital to output ratio, although it does underreport both a little. The model does well in capturing a higher income inequality for the entrepreneurs compared to workers. It also does well in capturing the population share of entrepreneurs and workers. Data shows that 5.25% of the population were employer-entrepreneurs and the model shows that about 5.8% of households are employer-entrepreneurs. The model overreports the income share of employer-entrepreneurs at the top quintile at around 16.74% while it is only 8.91% in the data. The model does fairly well in capturing a couple of untargeted moments as well. Particularly, the model does well in capturing various group level statistics, such as average income ratios between the occupation groups. The model also does a good job of capturing the overall income inequality in the model.

Table 3: **Internally Calibrated Parameters**

Parameter	Description	Value
Preferences		
β	Discount factor	0.87
$\bar{h}^w$	Labor supply of workers	0.78
Production		
ν^{se}	Span of control for self-employed entrepreneurs	0.59
ν^{em}	Span of control for employers	0.81
ϕ^e	Employer-entrepreneur collateral constraint	1.66
κ	Employer-entrepreneur fixed cost	0.05
ξ	Relative productivity difference	0.7
Idiosyncratic Productivity		
ρ_ϵ	Persistence of worker productivity	0.90
ρ_θ	Persistence of entrepreneurial ability	0.91
σ_ϵ	Standard deviation of worker productivity	0.26
σ_θ	Standard deviation of entrepreneurial ability	0.28
Aggregate Parameters		
ϕ_k	Adjustment cost of capital	1.5
η	Elasticity of interest rate to output	-0.03
ρ_z	Persistence of aggregate TFP	0.79
σ_z	Standard deviation of aggregate TFP	0.03

Note: This table lists parameter values that are chosen to match the moments in Table 4

Table 4: **Calibration Results**

Moment	Data	Baseline Model
Targeted Moments		
K/Y	2.54	1.83
B/Y	-0.32	-0.29
Bottom 40% worker income share	0.17	0.18
Bottom 40% entre. income share	0.11	0.15
Income Gini-workers	0.42	0.35
Income Gini-entre.	0.55	0.48
Population share of employer-entre.	4.76	5.8
Population share of workers	75.43	73.38
Top 10% of employer-entre. income share	8.91	16.74
Total self-employed entre. income share	16.40	12.10
Average entre. income/average worker income	1.13	1.18
Investment-to-output volatility	2.57	2.5
Correlation of output with trade balance	-0.79	-0.56
Aggregate output volatility	7.63	7.68
Aggregate output autocorrelation	0.7	0.66
Untargeted Moments		
Average employer income/average self-employed income	2.78	5.57
Income Gini-overall	0.46	0.40

5 Model Implications for Occupational Heterogeneity and Sudden Stop Dynamics

I evaluate the model on the basis of its ability to match the observed selection of households into the self-employed and employer entrepreneurship, as well as the distributional dynamics measured by the average relative income responses across occupations during sudden stops documented in the empirical analysis. First, I show that the model generates the selection of poor households into self-employment and rich households into employer entrepreneurship. Intuitively, entrepreneurs face a trade-off between the fixed cost of operating as an employer and scaling their businesses by hiring external labor.

Second, I simulate the model and identify sudden stop episodes. The baseline model successfully captures severe drops in output, consumption, and investment as well as the rise in the trade balance-to-GDP ratio during sudden stops, while the model without occupational choice fails to capture quantitatively drops in output and consumption. The aggregate dynamics depend on the population distribution because the aggregate variables depends on the extensive margin ie. distribution dynamics which are endogenous and the intensive margin where household's individual responses differ depending on their occupations.

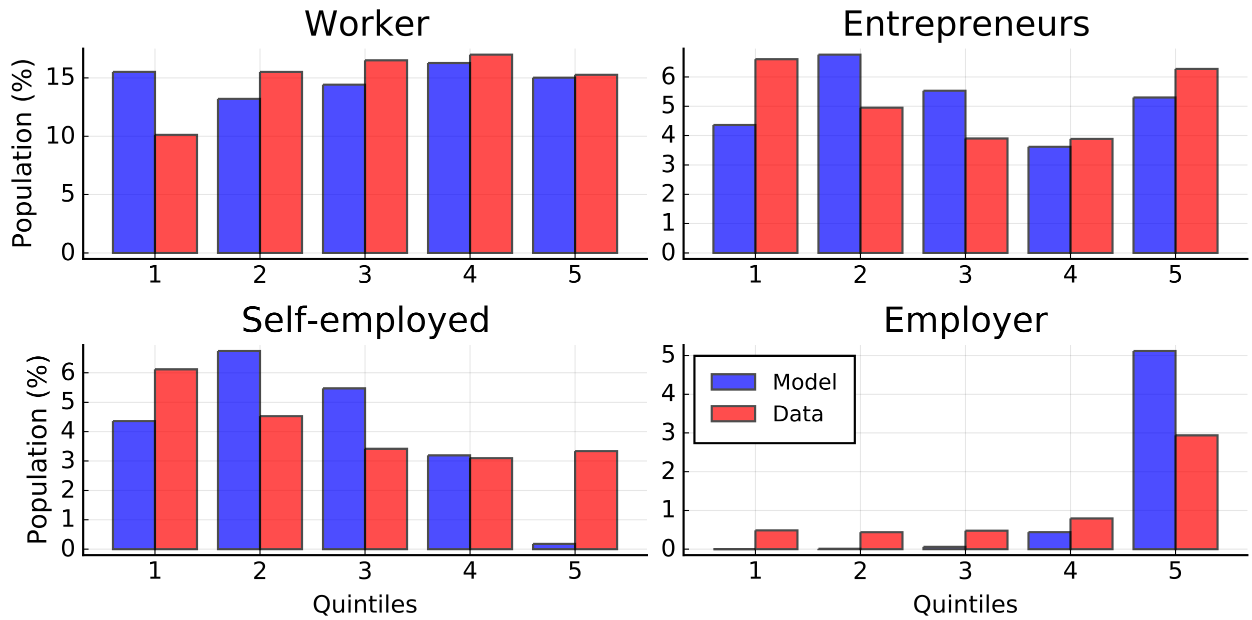
Third, I find that the baseline model can capture a key distributional effect that the dispersion of income across entrepreneurs increases relative to that of workers, which cannot be captured by the alternative model without self-employed entrepreneurs. I show that the higher degree of financial friction, the per-period fixed cost, and the ability to hire external labor play large roles in determining the heterogeneous responses of entrepreneurs across the income distribution.

5.1 Population Distribution in the Stationary Equilibrium

In Figure 3, I plot the selection of households across the income distribution into occupations in the stationary equilibrium. The top row presents the distribution of workers and entrepreneurs by their income quintiles. The model matches the empirical distribution of workers and entrepreneurs fairly well. Particularly, the model replicates the fact that most of the population are workers and that entrepreneurs mostly exist in the bottom and the top income quintiles. However, the model underreports the share of entrepreneurs in the first income quintile and overreports the share of entrepreneurs in the second income quintile. Quantitatively, the data reports that 6.6% of the population are entrepreneurs in the first income quintile while the baseline model reports that 4.1% of the population are entrepreneurs. In the second income quintile, 6.76% of the population are entrepreneurs in the model while it is 4.9% in the data. The discrepancy between the data and the model is led by a large portion of self-employed entrepreneurs in the second income quintile (5.63%) who are not financially constrained.

I now turn to an analysis of the distribution of self-employed entrepreneurs and employer-entrepreneurs, as shown in the second row of Figure 3. Self-employed entrepreneurs exist mostly in the lower income quintiles, whereas employer-entrepreneurs exist mostly in the top income quintile. However, the baseline model exaggerates the bimodality of entrepreneurship relative to the data. Quantitatively, the model overestimates the share of employer-entrepreneurs in the top income quintile, which is 5.1% in the model whereas it is 2.9% in the data. Additionally, the data imply that 3.3% of entrepreneurs in the top income quintile

Figure 3: Population Distribution Implied by the Model

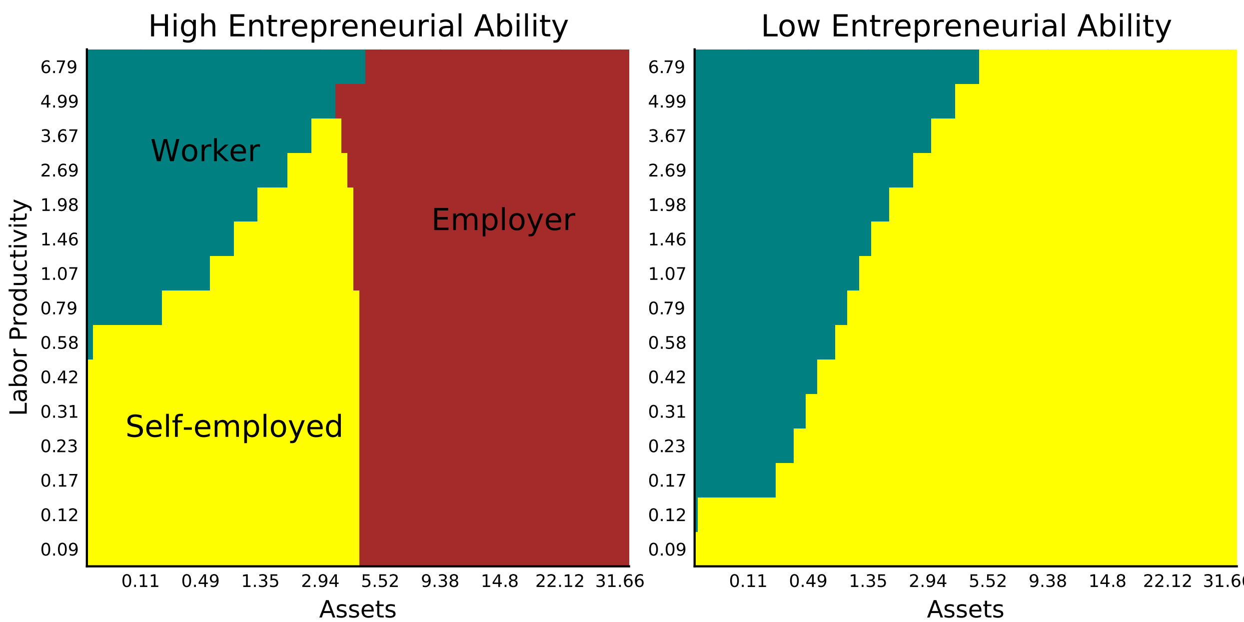


Note: This figure plots histograms of the distribution of households within the population by occupation across income quintiles in the model vs. in the data. The top row presents the population distribution of workers and entrepreneurs. The bottom row further distinguishes between self-employed entrepreneurs and employers.

are self-employed, while this percentage is 0.18% in the baseline model. This occurs because becoming an employer-entrepreneur is a costly choice, but when households are able to overcome the fixed cost, the profit is always higher than the income from other occupations. Thus, households with high entrepreneurial ability and high wealth always choose to be employer-entrepreneurs.

Why do individuals endogenously choose to be self-employed entrepreneurs at the bottom end of the income distribution and employer-entrepreneurs at the top of the income distribution? Figure 4 plots the decision rules for choosing occupations in the stationary equilibrium. The green area indicates the region in which an individual decides to be a worker, the yellow area indicates the region in which an individual decides to be a self-employed entrepreneur, and the red area indicates the region in which an individual decides to be an employer-entrepreneur. The left panel shows the choices for households with high entrepreneurial ability, and the right panel shows the choices for households with low entrepreneurial ability. There are three takeaways from this figure. The first takeaway is that

Figure 4: Occupational Choice



Note: This figure illustrates the occupational decision rules for workers, self-employed entrepreneurs, and employer-entrepreneur, colored green, yellow, and red, respectively. The right panel plots the decision rules for those with low entrepreneurial ability and the left panel plots the decision rules for those with high entrepreneurial ability.

the region in which households choose to become entrepreneurs (self-employed or employers) expands with entrepreneurial ability. Households choose to be workers in the region in which assets are low and labor productivity is high. The second takeaway is that households choose to be self-employed in the region in which both assets and labor productivity are low, while households choose to be employers in the high-assets region, as indicated by the red area. Last, for those with low entrepreneurial ability, it is never optimal for households to be employers.

These observations highlight the trade-off that exists between the fixed cost of being an employer entrepreneur and the potential for higher profit from hiring external labor that shapes the distribution of self-employed and employer entrepreneurs. Low entrepreneurial ability and low asset are associated with lower profits. It is difficult for households to overcome the entry cost and the cost of hiring workers that comes with being an employer. Therefore, households choose to be self-employed because that occupation has no barriers to entry. However, self-employment is less enticing when assets are high and entrepreneurial ability is high because the potential profit from being an employers is increasing in both dimensions. This helps overcome the per-period fixed cost and individuals are more likely to choose to become employer-entrepreneurs when they are either wealthy or have high levels of entrepreneurial productivity.

5.2 Crisis Simulation: Aggregate Dynamics

This section evaluates the model's performance in matching the estimates established in the empirical analysis. To replicate sudden stops, I use the following approach. First, I simulate the model for 2000 periods and drop the first 500 periods so that the simulated series does not depend on initial states. Second, I identify a time period as a sudden stop when the current account-to-GDP ratio rises by more than two standard deviations from its long-run mean and is followed by a decline in output, which is the same criterion used in the empirical literature to identify sudden stops. Third, I collect the results for the aggregate variables of interest and take their median across all episodes.

Figure 5 plots the results of the simulations. The solid blue line represents the baseline model described in the previous sections. I also compare the aggregate dynamics with those of two alternative models. The first alternative model ("workers"), represented by the solid yellow line, refers to the model without any occupational choice. This model is a simple heterogeneous-agent model with aggregate shocks in a small open-economy setting. The second alternative model ("standard") is a framework based on Buera et al. (2015) without the distinction between the self-employed and the employer-entrepreneur. This is represented by the solid green line. Finally, the dashed red line represents the data that takes the median of all sudden stop episodes from 1980-2015 in Argentina.

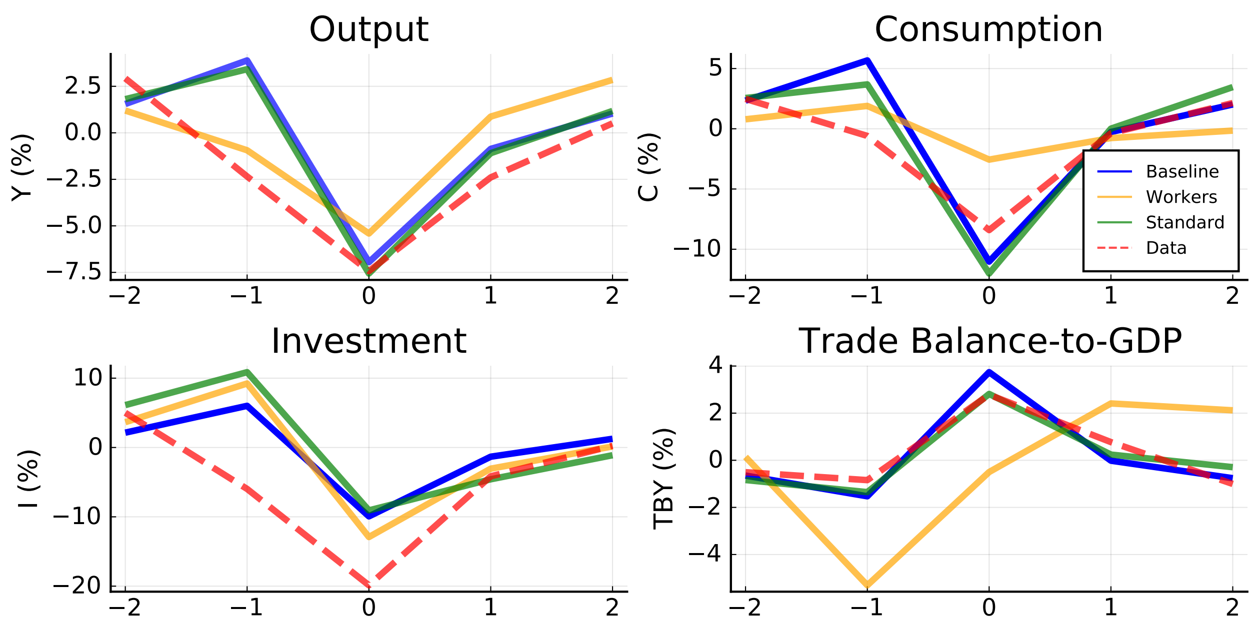
Quantitatively, output drops from 2.5% above the trend to 7.5% below the trend in the data. The baseline model and the standard model match the drop in the data almost exactly, while the model with only workers underestimates the drop in output. All models find large drops in investments as well which is consistent with the data. As shown in the right column, all models also find severe drops in consumption, but the model with only workers underreports the drop compared to the other models. Finally, the baseline and the standard model does well in capturing the large rise in the trade balance in the data, but the model with only workers does much worse. The model without the occupational choice has a deteriorating trade balance a year before a crisis whereas other models do not. These results indicate the importance of accounting for entrepreneurs in capturing important aggregate dynamics during sudden stops.

To explore the mechanisms behind the aggregate responses due to household heterogeneity, I decompose the deviation of aggregate income from its steady-state value, dY_t^{agg}, into the changes in the incomes of each occupation.

$$dY_t^{agg} = Y_t^{agg} - \bar{Y}^{agg} = (Y_t^w - \bar{Y}^w) + (Y_t^{se} - \bar{Y}^{se}) + (Y_t^{em} - \bar{Y}^{em}) = dY_t^w + dY_t^{se} + dY_t^{em} \tag{5}$$

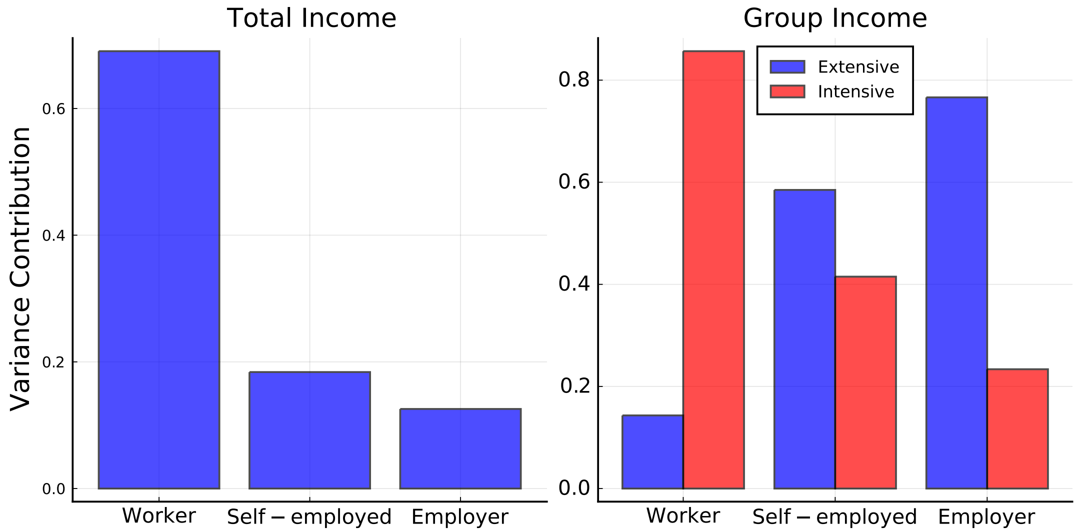
where w represents workers, se represents self-employed entrepreneurs, and em represents employers. Bars above variables denote values in the steady state. By taking the covariances

Figure 5: Model Implicatiosn for Sudden Stops: Aggregates



Note: This figure plots how output, consumption, investment, and trade balance-to-GDP ratio behave over a 5-year window. "Data" refers to the medians across all sudden stop episodes in Argentina shown as percentage deviations from their long-run means. The models also take the medians of all sudden stop episodes from the simulation, which are shown as percentage deviations from their steady state values.

Figure 6: Decomposition of Income Variance



Note: The figure in the left panel plots the contribution of each occupation's incomes variance to the variance of aggregate income. The figure in the right panel plots how the extensive (changes in the population share) and the intensive (changes in individual incomes) margins contribute to the variance of the changes in group-level income. The main takeaway is that the existence of entrepreneurs and of occupational choice are important mechanisms for explaining the aggregate dynamics.

of both sides of the equation, I can rewrite the above equation as follows.

$$var(dY_t^{agg}) = \sum_{j\in\{w,se,em\}} cov(dY_t^j, dY_t^{agg}) \tag{6}$$

$$1 = \sum_{j\in\{w,se,em\}} \frac{std(dY_t^j)}{std(dY_t^{agg})} corr(dY_t^j, dY_t^{agg}) \tag{7}$$

$$= \sum_{j\in\{w,se,em\}} \tilde{\beta}_j \tag{8}$$

$\tilde{\beta}_j$ represents the contribution of the volatility of occupation j's aggregate income to the volatility of total income. This contribution depends on the relative standard deviations and the correlation between the group's total income and aggregate income. To simplify the interpretation, I define β to be the normalized $\tilde{\beta}$ in absolute values.

$$\beta_{j,t} = \frac{\tilde{\beta}_{j,t}}{\sum_j |\tilde{\beta}_{j,t}|} \tag{9}$$

The left panel of Figure 6 plots β for each group defined previously. Quantitatively, β_w is approximately 0.7, which implies that changes in the income of workers explain approximately 70% of the volatility of aggregate income in the economy. This large contribution is driven by the fact that workers make up approximately 75% of the population. Changes in the income of self-employed entrepreneurs explain approximately 18% of the total volatility, while the changes for employer-entrepreneurs explain approximately 12%. Although employer-entrepreneurs make up only 5% of the population, their contribution to the volatility is larger because their income shares are higher. One can also rewrite the total income for occupation j as:

$$Y_t^j = \int_{o=j} y_t^j(s,S) d\Lambda_t(s,S), \tag{10}$$

where $d\Lambda(s,S)$ denotes the population distribution at time t and the incomes in each idiosyncratic and aggregate state $y_t^j(s,S)$. Thus, the total income of occupation j is driven by both the population distribution dynamics, which represent the extensive margin, and the incomes in each states, which represent the intensive margin. To evaluate the quantitative importance of each margin, I decompose the change in aggregate income into changes along the extensive and intensive margins. I rewrite the change in occupation j's total income as follows.

$$\begin{aligned} dY_t^j &= \underbrace{(\int_{o=j} y_t^j(s,S) d\overline{\Lambda}(s,S) - \int_{o=j} \bar{y}_t^j(s,S) d\overline{\Lambda}(s,S))}_{\text{Intensive margin}} \\ &+ \underbrace{(\int_{o=j} \bar{y}^j(s,S) d\Lambda_t(s,S) - \int_{o=j} \bar{y}^j(s,S) d\overline{\Lambda}_t(s,S))}_{\text{Extensive margin}} \\ &+ \underbrace{U_t - \bar{U}}_{\text{Residuals}} \\ &= d\mathcal{I}_t^j + dE_t^j + dU_t^j, \end{aligned} \tag{11}$$

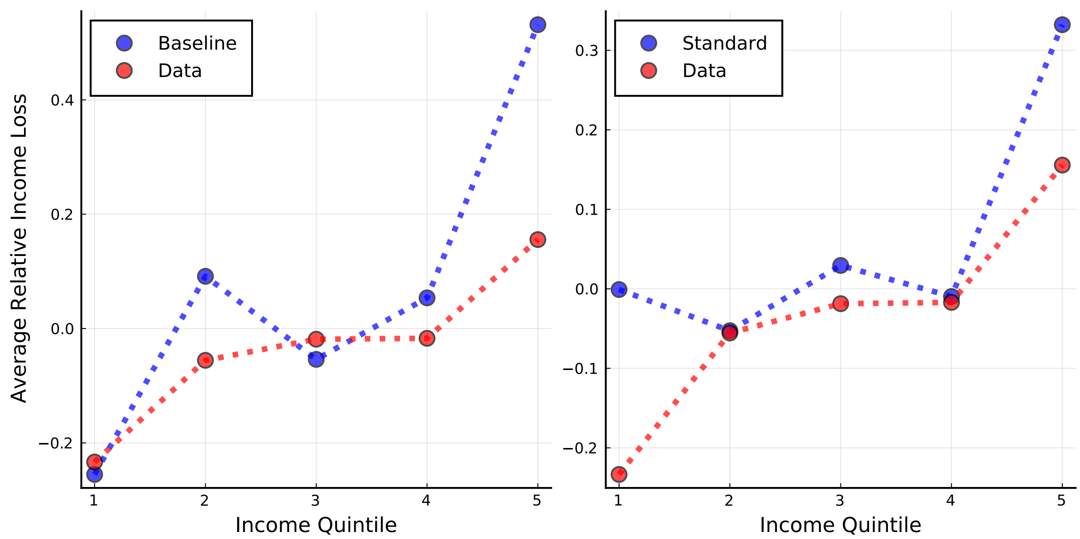
where bars above variables denote values in the stationary equilibrium and j denotes occupation. Following the variance decomposition procedure above, I calculate the β of the margins for each group's income. The results are shown in the right panel of Figure 6. This figure plots the intensive margin results, represented by the red bar, and the extensive margin results, represented by the blue bar, for each occupation. The normalized β for workers' extensive margin is 0.15, which implies that 15% of the total income volatility for the worker group can be attributed to changes in the population distribution of workers. The intensive margin for the worker group, on the other hand, has a higher value of 0.85, implying that 85% of the changes are driven directly by the income responses of workers holding the population distribution fixed. In contrast, the volatility of the entrepreneurial groups' incomes are driven mostly by the extensive margin. They are 0.6 and 0.8 for self-employed entrepreneurs and employer-entrepreneurs, respectively. This numerical exercise highlights the quantitative importance of taking the population distribution dynamics into account when dealing with occupational heterogeneity.

5.3 Crisis Simulation: Distributional Dynamics

Next, I evaluate the fit of the results from replicating the heterogeneity in relative average income losses across the income distribution. I simulate a panel of households during the sudden stop periods identified in the previous section. To do so, I recover the aggregate state variables associated with the sudden stops identifies from the simulated data. Holding them fixed, I solve the household's problem, then use the decision rules to simulate a panel dataset of households. Given the simulated data, I run the same regression as Section 2.3 to compare the average relative income losses between groups across the income distribution.

The left-hand panel of Figure 7 compares the estimates from the baseline model and data while the right-hand panel of Figure 7 presents results from the "standard" model and data. In the first quintile, the baseline model matches the empirical estimate almost exactly while the standard model is not able to capture this. This finding solidifies the necessity of distinguishing between the types of entrepreneurs to capture the widening of the income distribution among entrepreneurs relative to that among workers. The baseline model is less successful in replicating the empirical estimates for the middle of the income distribution. Notably, the baseline model reports a slightly positive coefficient for the second quintile but that coefficient is negative in the data. This is driven by the fact that most entrepreneurs in the second quintile are self-employed entrepreneurs who are not financially constrained. This means that due to the wealth effects of supplying labor, these entrepreneurs tend to work more to counteract the loss in income from negative productivity shocks, which leads to a lower income loss relative to that of workers. At the top of the income distribution,

Figure 7: Model Implications for Sudden Stops: Distributional Dynamics



Note: The figure in the left panel plots the coefficients of interest from the baseline model for workers, self-employed entrepreneurs, and employer-entrepreneurs in each quintile. The figure in the right panel plots the coefficients of interest from the standard model for each quintile. The standard model refers to the model that does not distinguish between self-employed entrepreneurs and employer-entrepreneurs. The main takeaway is that the baseline model is able to capture the greater income loss for entrepreneurs at the bottom of the income distribution and the smaller income loss at the top of the income distribution.

both models overestimate the average income responses of entrepreneurs relative to the empirical estimate. The reason for this could be related to either mismeasurement in the data or the higher average income of employer-entrepreneurs in the model than in the the data. The individual-level survey is top-coded, unlike alternative sources such as tax returns. Therefore, using the current individual survey misses many entrepreneurs at the very top of the income distribution who help drive the increase the inequality during sudden stops. Second, in the baseline model, the average income of the employer-entrepreneurs is 5 times higher than that of the self-employed entrepreneurs, whereas it is only 3 times higher in the data. The population distribution implied by the model also underestimates the share of self-employed entrepreneurs and overestimates the share of employer-entrepreneurs. Thus, if the distinction between self-employed entrepreneurs and employer-entrepreneur is crucial, it is reasonable to think that the moment from the model will be an overestimate of the empirical moment in the top quintile.

Similar to the previous section, I decompose the change in the average income responses of entrepreneurs to sudden stops across the income quintiles into several channels and quantify the sources of variation. I define the change in the average income of entrepreneurs (including both self-employed entrepreneurs and employers) at quintile q as

$$\begin{aligned} dY_t^{avg,q}(k_t, h_t, l_t; z_t, u_t, r_t, w_t, d\Lambda_t) = \\ & \underbrace{dY_t^{avg,q}(\bar{k}, \bar{h}, \bar{l}; z_t, \bar{u}, \bar{r}, \bar{w}, d\bar{\Lambda})}_{\text{Direct channel}} + \underbrace{dY_t^{avg,q}(\bar{k}, \bar{h}, \bar{l}; \bar{z}, \bar{u}, \bar{r}, \bar{w}, d\Lambda_t)}_{\text{Distributional channel}} \\ & + \underbrace{dY_t^{avg,q}(\bar{k}, h_t, l_t; \bar{z}, \bar{u}, \bar{r}, w_t, d\bar{\Lambda})}_{\text{Labor market channel}} + \underbrace{dY_t^{avg,q}(k_t, \bar{h}, \bar{l}; \bar{z}, u_t, \bar{r}, \bar{w}, d\bar{\Lambda})}_{\text{Capital market channel}} \\ & + \underbrace{dY_t^{avg,q}(\bar{k}, \bar{h}, \bar{l}; \bar{z}, \bar{u}, r_t, \bar{w}, d\bar{\Lambda})}_{\text{Interest rate channel}} + \underbrace{dU_t}_{\text{Residual}} \end{aligned} \tag{12}$$

where the residual term is designed to capture any effects that are not captured by the other terms in the equation.

In Figure 8, I plot the normalized β for the first and fifth quintiles to highlight the mechanisms behind the results shown in Figure 5. The direct effect is the major contributor to the income losses of both rich and poor entrepreneurs, but the impact is less for rich entrepreneurs at approximately 60% compared with that of poor entrepreneurs at approximately 70%.

The distributional channel represents the change in the population distribution within the income quintile, which contributes approximately 15% to the volatility in the average income of poor entrepreneurs, while the contribution is much lower for rich entrepreneurs. The greater contribution for poor entrepreneurs highlights two mechanisms: a lack of barriers to entry and a higher degree of financial frictions. First, self-employed entrepreneurs face no barriers to entry or exit, which implies that changes to the population distribution are amplified relative to those for rich entrepreneurs, who are mostly employers with per-period fixed costs. Second, the existence of the collateral constraint on capital for self-employed entrepreneurs increases the share of constrained entrepreneurs, which amplifies the income response.

The labor market channel also displays a large amount of heterogeneity between the rich and poor entrepreneurs. While the labor market channel does not contribute much to the income loss of poor entrepreneurs with a β of close to 0, the contribution is much greater in absolute values for the rich entrepreneurs. This quantitative difference emphasizes the role that labor input heterogeneity plays in shaping the distributional outcomes. First, self-employed entrepreneurs use only their own labor supply as an input into their production function. This implies that any changes to labor market conditions, such as declines in real wages, have virtually no effect on their income response. In contrast, employer-entrepreneurs hire workers as inputs into their production function. Declines in real wages during a crisis help mitigate the income loss from the direct productivity shock because the fall in real wages reduces the cost of labor. This can be seen from the negative β in the labor market channel. Finally, the interest rate positively affects poor entrepreneurs' incomes because it raises their capital incomes, but it plays a minimal role for rich entrepreneurs. This is because the increase in capital income is offset by the increase in the per-period fixed cost of operations for employer-entrepreneurs.

These results imply that poor entrepreneurs, who are mostly self-employed, have the least self-insurance due to financial frictions and their inability to hire workers. On the other hand, rich entrepreneurs, who are mostly employers, has several ways of self-insuring during a crisis, such as through the adjustment of the labor input and the fall in real wages, which mitigates some of the income losses from a negative productivity shock.

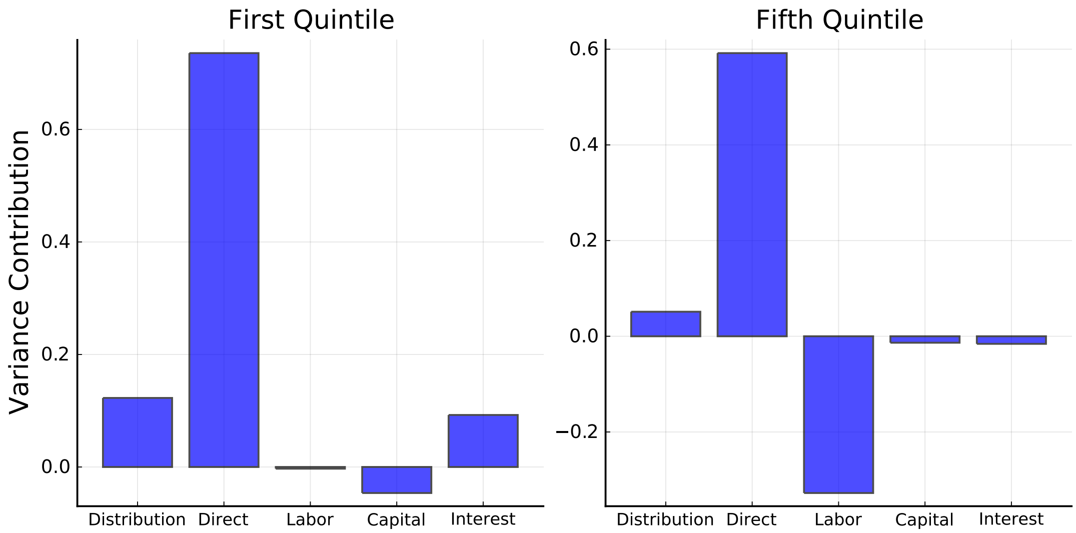
6 Impact of a Capital Tax to Sudden Stop Dynamics

In this section, I quantitatively show that imposing a flat capital tax reduces both the crisis probability and the long-run welfare because it disincentivizes entrepreneurships. During a financial crisis, the population distribution dynamics differ because a tax distorts individuals' occupational choices on the margin. The changes in the population dynamics affect aggregate and distributional impacts during sudden stops as well. I assume that the government introduces a flat tax to assets and capital to households.[9]

Macroprudential policy in my model raises the cost of borrowing capital and reduces

[9]This policy is related to capital controls, which are residency-based policies such as taxations and other limits to regulate international capital flows. Literatures such as Bianchi (2011), Korinek and Sandri (2016), and Benigno et al. (2013) find that capital controls are successful in reducing the probability of a crisis and improve long-run welfare in an emerging market.

Figure 8: Sources of Variation of Entrepreneur's Income



Note: The graph plots the contribution of variance for entrepreneurs' average income in the first and the fifth income quintiles into five channels: distributional, direct, capital market, labor market, and interest rate.

Table 5: Crisis Probability

	No Capital Tax	Capital Tax
Crisis Probability	4.3	1.7

Note: This table lists the probability of a sudden stop episode occuring according to the economy without a capital tax, and with a capital tax.

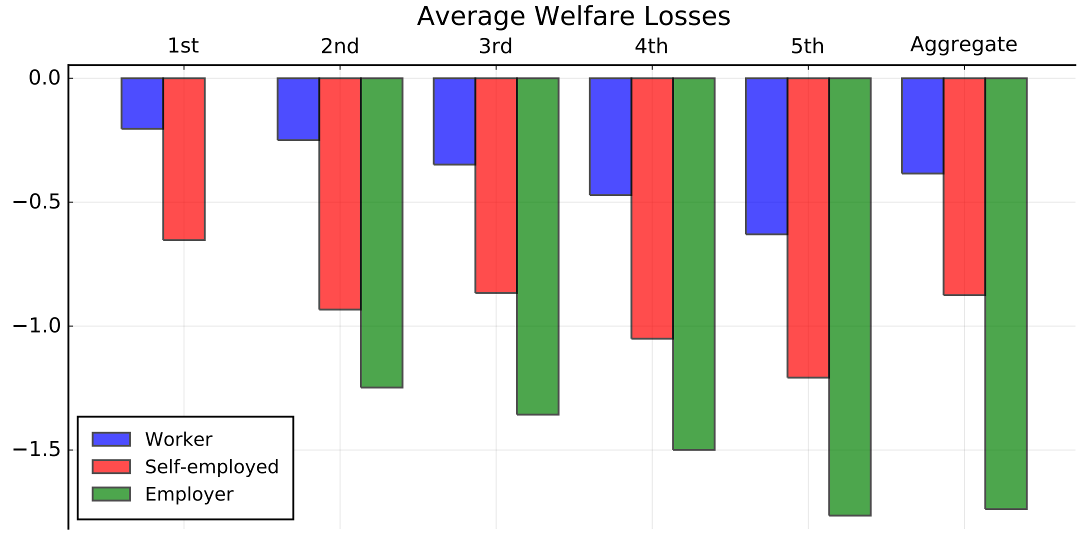
the return on savings. These price distortions disincentivize entrepreneurs on the margin because they reduce business profits and the asset accumulations that are used to collateralize capital. The resulting changes in the population distribution have benefits and costs for the economy. First, the tax dampens the volatility of external balances because capital and assets directly impact the current account and the trade balance, which improves financial stability. Table 5 lists the probability of sudden stops occuring under the baseline calibration without any taxes and the model with a tax. Therefore, the benefit of the macroprudential tax is a reduction in the crisis probability from 4.3% to 1.7%. However, as noted before, a tax discourages households from becoming entrepreneurs on the margin. Wealthy employer-entrepreneurs account for a significant share of consumption and output. Therefore, when there are fewer wealthier entrepreneurs, economy is inevitably hurt in the long-run, which is a cost of implementing such tax.

Figure 9 plots the average welfare losses from a tax on capital and assets across the income distribution and by occupation. While all households favor the economy without taxes, there is notable heterogeneity to note across occupations and the income distribution. In general, richer households experience a greater welfare loss because they have larger stocks of assets. Among the occupations, employer-entrepreneurs experience the largest welfare loss, followed by self-employed entrepreneurs and then workers. This is because employer-entrepreneurs have a larger stock of capital on average and pay the most under the taxation.[10] These results highlight the trade-offs between the long-run economy and financial stability from a capital tax.

How do the aggregate and distributional dynamics change during sudden stops? I first explore the mechanism by which a tax on capital and assets affects these dynamics. As noted before, in the long-run, capital tax affects the choice of occupation by the household on the margin This phenomenon also occurs outside the stationary equilibrium. Figure 10 plots the impulse response functions for the changes in the population shares in response to a negative productivity shock. In the baseline calibration, represented by the blue line, there

[10] The consumption equivalent welfare change at state s is defined as $W(s) = \left[\left(\frac{\tilde{v}(s)}{v(s)}\right)^{\frac{1}{1-\gamma}} - 1\right]$, where v is the value function in the baseline economy, and $\tilde{v}$ is the value function associated with the economy with a tax.

Figure 9: Average Welfare Losses from a Capital Tax: Long-Run



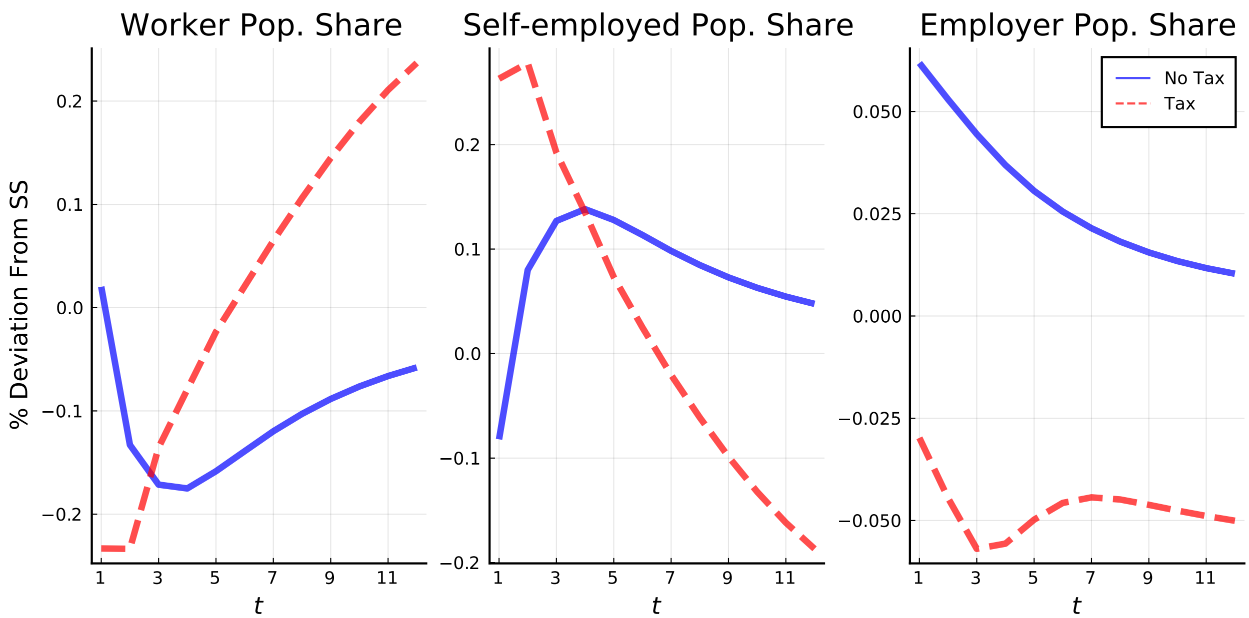
Note: This figure plots the average long-run welfare losses from a capital tax across the income distribution and by occupation. Welfare is expressed as a percentage of consumption.

is a general movement of workers out of the labor force and choosing into entrepreneurship during a recession due to low labor demand. While the share of self-employed entrepreneurs in the population declines slightly on impact, it quickly increases after two years. This occurs because poorer workers face fewer opportunities due to lower labor demand. In searching for new opportunities, workers on the margin find it better to be self-employed entrepreneurs due to the lack of entry barriers.

Why does the population share of employer-entrepreneurs rise during a recession? This occurs because households on that margin face two tradeoffs. First, in a high-interest rate environment, the per-period fixed cost of running a business as an employer, which is given by $(1 + r_t)\kappa$ increases. This discourages households from becoming employers. Second, due to the high interest rate, households are more likely to accumulate assets, which makes some households more likely to become employers. The second effect is greater than the first effect which leads to a slight increase in the population share of employer-entrepreneurs on impact. However, the share quickly declines after a couple of periods.

The population dynamics for the scenario with a capital tax is represented by the dashed

Figure 10: Population Dynamics

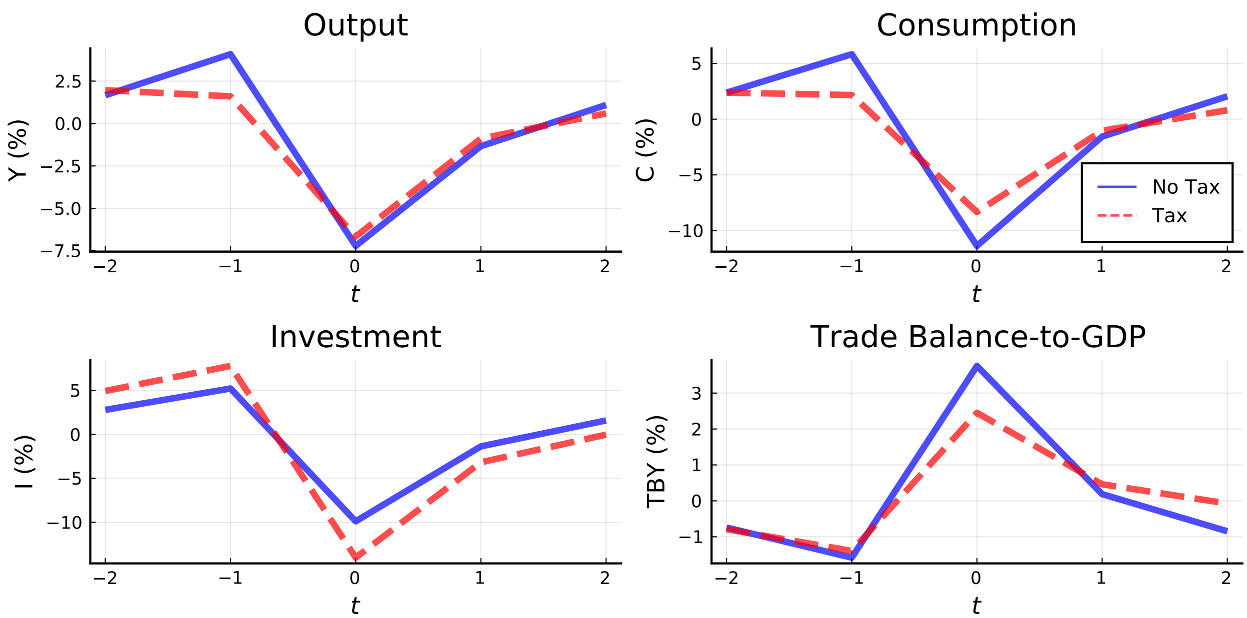


Note: This figure plots the population dynamics for workers, self-employed entrepreneurs, and employer-entrepreneurs in response to a negative productivity shock.

red line. The population share of workers drops on impact by 0.3%, while the drop is more gradual in the baseline model. Similarly, the share of self-employed entrepreneurs in the population rises on impact by more than 0.2%, while the rise is more gradual in the baseline model. The share of employer-entrepreneurs in the population rises in the baseline model but declines with high persistence in the model with a capital tax. This is consistent with the previous result that shows that employer-entrepreneurs are impacted the most by the capital tax. Looking at the longer horizon, I find that a capital tax discourage both types of entrepreneurships as indicated by the declining population shares of all entrepreneurs.

These changes in population dynamics impact how aggregate variables behave during sudden stops. Figure 11 plots how aggregate consumption, output, investment, and trade-balance behaves during sudden stops. The baseline model without any taxes is represented by the solid blue line and the scenario with a tax is represented by a dashed red line. I find that consumption drops less while I do not find a difference in the output drops. Trade balance also rises less which is driven by the dampened external capital flows. Investment experiences a higher drop compared to the baseline without any taxes. What happens to the distributional

Figure 11: Implications of a Capital Tax for Sudden Stops: Aggregates



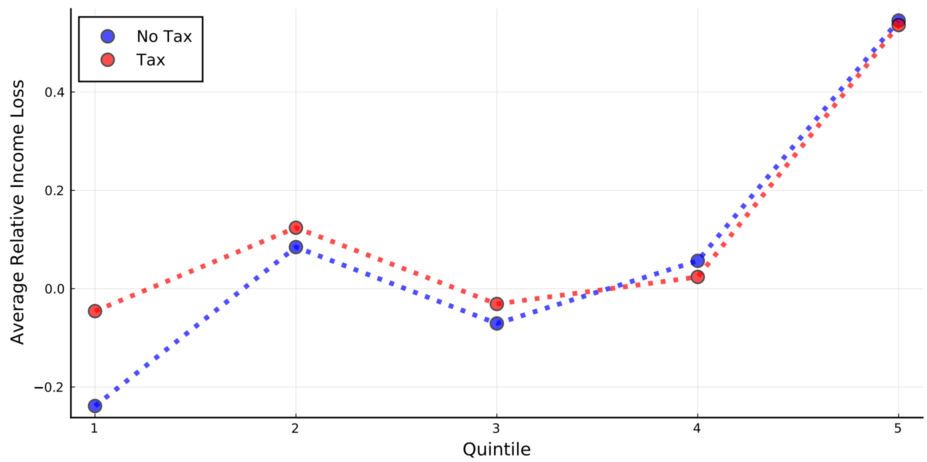
Note: This figure plots how output, consumption, investment, and the trade balance-to-GDP ratio behave over a 5-year window. All values are shown as percentage deviations from its steady state values.

impact? Figure 12 plots the heterogeneous relative income responses of entrepreneurs across the income distribution by running the same set of regressions as the previous sections. The income distribution of entrepreneurs widens less relative to the baseline as indicated by the flatter regression estimate across the income distribution, particularly in the first income quintile. This result highlights the fact that a tax changes the population distribution dynamics, which in turn, affect the aggregate and distributional impacts. It particularly lowers the impact that entrepreneurs have on driving the income inequality during sudden stops.

7 Conclusion

This paper argues that occupational heterogeneity at the household level helps explain the aggregate and distributional implications during sudden stops using two approaches. First, using detailed household microdata, I find that the entrepreneurial group's income distribu-

Figure 12: Implications of a Capital Tax for Sudden Stops: Distributional



Note: This figure plots the regression results from a tax vs. without a tax.

tion widens relative to the worker's income distribution. Second, I embed an occupational choice model that distinguishes self-employed entrepreneurs from employers into a standard small open-economy setting with aggregate shocks. When evaluating the distributional impact of sudden stops, this distinction is shown to be pivotal in capturing the heterogeneity in income responses between occupations in the bottom quintile of the income distribution. Through various decomposition exercises, I establish that *1)* in explaining the variance in aggregate income, entrepreneurs contribute 30% of the total volatility, while the extensive margin explains the majority of the entrepreneurial income volatility and *2)* a higher degree of financial friction for self-employed entrepreneurs, a per-period fixed cost for employers, and the heterogeneity in labor input between the two types of entrepreneurs explain the heterogeneous in the income responses across the income distribution. In terms of policy, a capital tax which mimics capital controls reduces the probability of a crisis but at the cost of the long-run economy. Aggregate and distributional dynamics during sudden stops change with a capital tax because of differences in the response of the population distribution dynamics to aggregate shocks. Overall, my findings suggest that household heterogeneity with occupational choice introduces a new dimension that clarifies the impact of sudden stops on inequality in emerging markets.

This paper establishes that the entrepreneurs at the bottom and the top end of the income distribution are important for explaining inequality during sudden stops. However, several questions naturally remain. First, across the income distribution, which groups contribute the most to the aggregate income volatility over the business cycle? Second, I have abstracted away from nominal rigidities, but in the data, nominal wages are downwardly rigid especially during a financial crisis. In my model, movements in real wages helped explain much of the variation in rich employer-entrepreneurs' income, and incorporating price rigidities and exchange rate policies would bring the model closer to the data. Finally, studying optimal policies in the presence of heterogeneity would enrich the analysis.

References

Aguiar, M. and Gopinath, G. (2007). Emerging Market Business Cycles: The Cycle Is the Trend. *Journal of Political Economy*, 115(1):69–102.

Aiyagari, S. R. (1994). Uninsured Idiosyncratic Risk and Aggregate Saving. *The Quarterly Journal of Economics*, 109(3):659–684.

Allub, L. and Erosa, A. (2019). Financial frictions, occupational choice and economic inequality. *Journal of Monetary Economics*, 107:63–76.

Anchorena, J. and Ronconi, L. (2012). Entrepreneurship, Entrepreneurial Values, and Public Policy in Argentina. *IDB Working Paper Series*, page 53.

Bayer, C. and Luetticke, R. (2018). Solving heterogeneous agent models in discrete time with many idiosyncratic states by perturbation methods. *CEPR DP No. 13071*, page 35.

Benigno, G., Chen, H., Otrok, C., Rebucci, A., and Young, E. R. (2013). Financial crises and macro-prudential policies. *Journal of International Economics*, 89(2):453–470.

Bianchi, J. (2011). Overborrowing and Systemic Externalities in the Business Cycle. *American Economic Review*, 101(7):3400–3426.

Buera, F. J., Kaboski, J. P., and Shin, Y. (2011). Finance and Development: A Tale of Two Sectors. *American Economic Review*, 101(5):1964–2002.

Buera, F. J., Kaboski, J. P., and Shin, Y. (2015). Entrepreneurship and Financial Frictions: A Macro-Development Perspective. *Annual Review of Economics*, page 39.

Cagetti, M. and De Nardi, M. (2006). Entrepreneurship, Frictions, and Wealth. *Journal of Political Economy*, 114(5):36.

Calvo, G. A., Izquierdo, A., and Mejia, L.-F. (2004). On the Empirics of Sudden Stops: The Relevance of Balance-Sheet Effects. *NBER Working Paper*, page 48.

Casalí, P., Jiménez, M., Lépore, E., Ortega, L., and Alvarez, M. (2017). Social Security for Self-Employed Workers in Argentina: Policy Design, Coverage, and Funding. *Journal of Monetary Economics*, page 4.

Cugat, G. (2019). Emerging Markets, Household Heterogeneity, and Exchange Rate Policy. *mimeo*, page 69.

de Ferra, S., Mitman, K., and Romei, F. (2019). Household Heterogeneity and the Transmission of Foreign Shocks. Technical Report w26402, National Bureau of Economic Research, Cambridge, MA.

García-Cicco, J., Pancrazi, R., and Uribe, M. (2010). Real Business Cycles in Emerging Countries? *American Economic Review*, 100(5):2510–2531.

Granda, C. and Hamann, F. (2015). Informality, Saving and Wealth Inequality in Colombia. *SSRN Electronic Journal*.

Hong, S. (2020). Emerging Market Business Cycles with Heterogeneous Agents. *mimeo*, page 89.

Huggett, M. (1992). The risk-free rate in heterogeneous-agent incomplete-insurance economies. *Journal of Economic Dynamics and Control*.

Korinek, A. and Mendoza, E. G. (2014). From Sudden Stops to Fisherian Deflation: Quantitative Theory and Policy. *Annual Review of Economics*, 6(1):299–332.

Korinek, A. and Sandri, D. (2016). Capital controls or macroprudential regulation? *Journal of International Economics*, 99:S27–S42.

Kwark, N.-S. and Ma, E. (2020). Entrepreneurship and Income Distribution Dynamics: Why Is the Income Share of Top Income Earners Acyclical over the Business Cycle? *International Economic Review*, page 53.

Liu, Z., Spiegel, M. M., and Zhang, J. (2020). Capital Controls and Income Inequality. *Federal Reserve Bank of San Francisco, Working Paper Series*, pages 01–51.

Lopez-Martin, B. (2018). Informal Sector Misallocation. *Macroeconomic Dynamics*, page 42.

Lucas, R. E. (1978). On the Size Distribution of Business Firms. *The Bell Journal of Economics*, 9(2):508–523.

Mendoza, E. G. (1994). Real Business Cycles in a Small Open Economy. *American Economic Review*, 81(4):797–818.

Mendoza, E. G. (2010). Sudden Stops, Financial Crises, and Leverage. *American Economic Review*, 100(5):1941–1966.

Midrigan, V. and Xu, D. Y. (2014). Finance and Misallocation: Evidence from Plant-Level Data. *American Economic Review*, 104(2):37.

Quadrini, V. (2000). Entrepreneurship, Saving, and Social Mobility'. *Review of Economic Dynamics*, page 40.

Reiter, M. (2009). Solving heterogeneous-agent models by projection and perturbation. *Journal of Economic Dynamics and Control*, 33(3):649–665.

Schmitt-Grohé, S. and Uribe, M. (2003). Closing small open economy models. *Journal of International Economics*, 61(1):163–185.

Schmitt-Grohé, S. and Uribe, M. (2016). Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment. *Journal of Political Economy*, 124(5):1466–1514.

Villalvazo, S. (2020). Inequality and Asset Prices during Sudden Stops. *mimeo*, page 54.

Young, E. R. (2010). Solving the incomplete markets model with aggregate uncertainty using the Krusell–Smith algorithm and non-stochastic simulations. *Journal of Economic Dynamics and Control*, 34(1):36–41.

8 Appendix

8.1 Computational Algorithm

The baseline model contains multiple idiosyncratic productivity shocks, multiple aggregate shocks, and discrete choice at the household level. To discretize the idiosyncratic shocks, I use a Monte Carlo simulation. Because the distribution will be highly skewed, I include more grid points at lower assets to capture the high curvature. Furthermore, due to the discrete choice, I resort to using a value function iteration with a linear spline. In order to incorporate multiple aggregate shocks, I linearize the model with only respect to aggregate shocks but solve the steady state in a completely nonlinear fashion following Reiter (2009). General steps are as follows:

1. Solve for the steady state given a world interest rate.

    (a) Given r^*, calculate factor prices u, w from the corporate firm's FOC.

    (b) Given prices, solve the household problem, which is solved using a value function iteration with a linear spline to evaluate the value function off the grid points.

    (c) Given the solution to the household problem, simulate the distribution as in Young (2010).

2. Linearize the model with only respect to aggregate shocks

    (a) Jacobian is calculated by taking numerical differentiations

    (b) Using the copula method from Bayer and Luetticke (2018), one can reduce the dimension by expressing the joint distribution into functions of marginal distributions. This reduces the number of state variables from $n\theta \times n\epsilon \times na$ to $n\theta + n\epsilon + na$.

3. Solve the linearized model using Klein's method.

8.1.1 Details on Solving the Model

There are two infinite dimensional objects in the model that need to be approximated, which are the value functions and the distribution of households over the idiosyncratic states. The value functions with both idiosyncratic and aggregate shocks can be written as follows.

$$v_t^w(s_t, S_t) = \max_{c_t, a_{t+1}} \{u(c_t, \bar{h}^w) + \beta \mathbb{E}[v_{t+1}(s_{t+1}, S_{t+1}|s_t, S_{t+1})]\} \tag{13}$$

$$c_t^w(s_t, S_t) + a_{t+1}(s_t, S_t) = w_t(S_t)\bar{h}^w \epsilon_t + (1 + r_t(S_t))a_t \tag{14}$$

$$v_t^s(s_t, S_t) = \max_{c_t^s, a_{t+1}^s} \{u(c_t^s(s_t, S_t), h_t^s(s_t, S_t)) + \beta \mathbb{E}[v(s_{t+1}, S_{t+1})|s_t, S_t]\} \tag{15}$$

$$c_t^s(s_t, S_t) + a_{t+1}(s_t, S_{t+1}) = \pi_t^s(s_t, S_t) + (1 + r_t(S_t))a_t \tag{16}$$

$$\pi_t^s(s_t, S_t) = \max_{k_t^s, h_t^s} z_t \theta_t \xi (k_t^{s\alpha} h_t^{s1-\alpha})^\nu - (u_t + m)k_t \tag{17}$$

$$v_t^e(s_t, S_t) = \max_{c_t^e, a_{t+1}^e} \{u(c_t^e(s_t, S_t), \bar{h}^e) + \beta \mathbb{E}[v(s_{t+1}, S_{t+1})|s_t, S_t]\} \tag{18}$$

$$c_t^e(s_t, S_t) + a_{t+1}(s_t, S_{t+1}) = \pi_t^e(s_t, S_t) + (1 + r_t(S_t))a_t \tag{19}$$

$$\pi_t^e(s_t, S_t) = \max_{k_t^e, l_t^e} z_t \theta_t (k_t^{e\alpha} (\bar{h}^e + l_t^e)^{1-\alpha})^\nu - (u_t(S_t))k_t^e(s_t, S_t) - w_t(S_t) l_t^e(s_t, S_t) - (1 + r_t(S_t))\kappa \tag{20}$$

$$v_t(s_t, S_t) = \max\{v^w(s_t, S_t), v^s(s_t, S_t), v^e(s_t, S_t)\} \tag{21}$$

Value functions are approximated by a linear spline. I first calculate the prices in the steady state and turn off all aggregate shocks. In this step, the conditional expectations for the value functions are only taken with respect to idiosyncratic shocks. Given that the value function can be approximated with a linear spline, one can maximize each value functions on the RHS using Brent's method. And then the household's equilibrium dynamics with aggregate shocks can be characterized by the above set of equations, where $s_t = (a_t, \epsilon_t, \theta_t)$ are idiosyncratic state variables at time t while $S_t = (B_t, K_t, \Lambda_t)$ will be aggregate state variables at time t.

The second inifinite dimensional object in the model to be approximated is the distribution of the idiosyncratic state. This is done with a histogram method as in Young (2010). Let $a'(s, S)$ be the savings function for the household's that maximizes their value functions. Then the distribution over households can be summarized by a transition matrix Q, where each element $Q_{i,i'}$ is the probability that a type i will be type i'. This can be obtained by

$$Q_{i,i'} = \mathbb{P}[(a^{i'} = a_j, \epsilon^{i'} = \epsilon_s, \theta^{i'} = \theta_k)|(a^i, \epsilon^i, \theta^i)] \tag{22}$$

$$= w_{ij}\mathbb{P}(\epsilon_s, \theta_k|\epsilon^i\theta^i) \tag{23}$$

In the case of the stationary equilibrium, the steady state distribution over households is a histogram $\Lambda(s)$ that satisfies the following condition:

$$\Lambda = Q\Lambda \tag{24}$$

With aggregate shocks, the equilibrium dynamic must satisfy the following:

$$\Lambda_{t+1} = Q_t\Lambda_t \tag{25}$$

where Q_t is generated by the savings function $a'(s_t, S_t)$.

Furthermore, we need equations that describe the aggregate capital stock, bonds, two aggregate shocks, and the interest rate in order to make the model stationary. This completes the minimum number of equations in order to fully characterize the equilibrium dynamics in my model.

Given the distribution and the value functions, all other auxiliary aggregate variables such as output, consumption, and investment can be calculated from the value functions (and its resulting savings/consumption functions) and the resulting distribution.

The equilibrium dynamic can be represented by a set of nonlinear equations (shown above) which then can be written as:

$$\mathbb{E}_t F(X_t, X_{t+1}, Y_t, Y_{t+1}) = 0 \tag{26}$$

where Y_t is the set of control variables (such as value functions or aggregate output), and X_t is the set of state variables (such as the distribution Λ_t or aggregate capital K_t). The high dimensionality of this system makes the computation nearly infeasible. Therefore, I pursue a dimension reduction technique as Bayer and Luetticke (2018) for the distribution of households. It involves writing the distribution using a copula function such that $\Lambda_t = \mathcal{C}(M_t^a, M_t^\epsilon, M_t^\theta)$, where M_t^i is the marginal distribution for the variable i. This reduces the number of state variables from $n\theta \times n\epsilon \times na$ to $n\theta + n\epsilon + na$ and the perturbation is only done with respect to the marginals instead of the joint distribution.

Thus, linearizing the model with respect to aggregate shocks gives the following linear dynamic system.

$$X_{t+1} = H_x X_t + \eta \epsilon_{t+1} \tag{27}$$

$$Y_t = G_x X_t \tag{28}$$

which then can simulate the model, calculate second moments, and perform impulse response analysis.

8.2 Additional Empirical Results

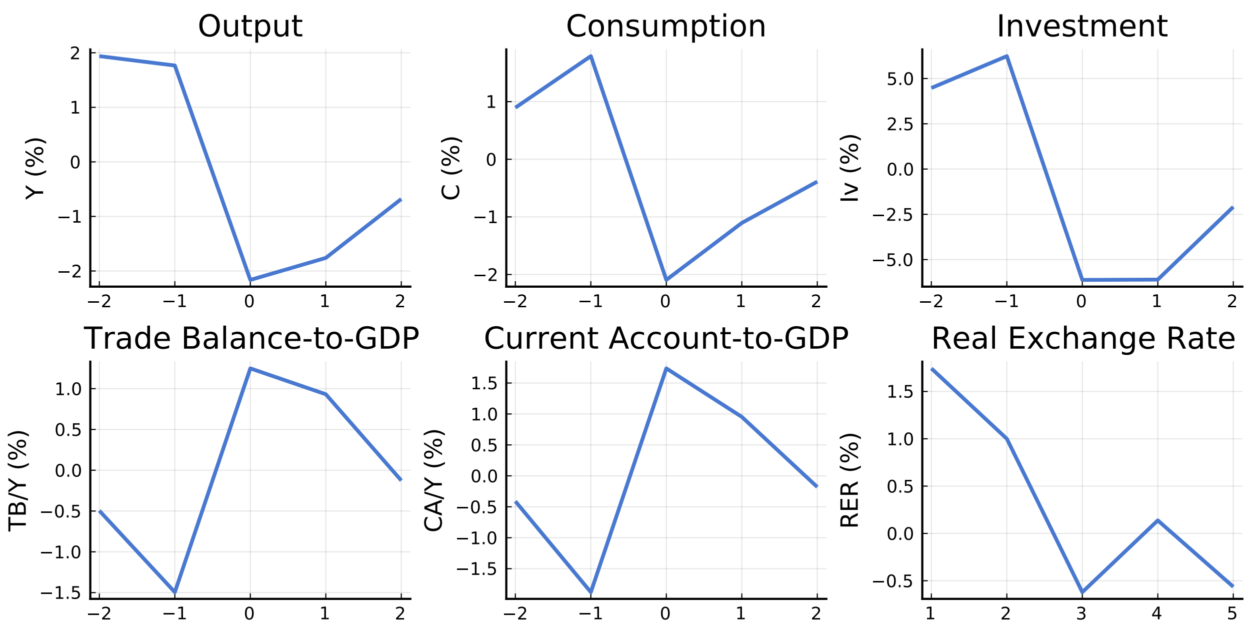
This section provides additional empirical results.

8.3 Aggregate Implications

Sudden stops are triggered by a sharp reversal in the international capital flow, which is typically measured by either the current account deficit or the foreign reserves. Furthermore, sudden stops are associated with a drop in output, consumption, and investment in response to the reversal of the international capital flow. Thus, the standard method of identifying sudden stops is by applying a filter based on two criteria: i.) a sharp decline in the current account deficit, which is typically a two standard deviation drop from its long-run mean, and ii.) a decline in output so that the decline in the current account deficit is not due to the boom.

I extend the analysis described in Korinek and Mendoza (2014) and Calvo et al. (2004) with a more recent dataset. Data on output, consumption, investment, trade balance-to-GDP, current account-to-GDP, and real exchange rates come from World Development Indicators (WDI) database. Sudden stops are identified following the methodology described by Korinek and Mendoza (2014) using the International Financial Statistics (IFS) data on foreign capital flows. Out of 29 economies from 1980 to 2019, the filter identifies 32 episodes which imply a crisis probability of 2.8%.

Figure 13: Sudden Stops: Aggregate Implications



Note: This figure plots a 5 year window of various macroeconomic variables averaged across all sudden stop episodes in the dataset. Output, consumption, investment, trade balance-to-GDP, and current account-to-GDP are HP filtered with a lambda of 6.25 and units are in percentage deviation from its trend. Real exchange rate is in percentage deviations from its long-run mean.

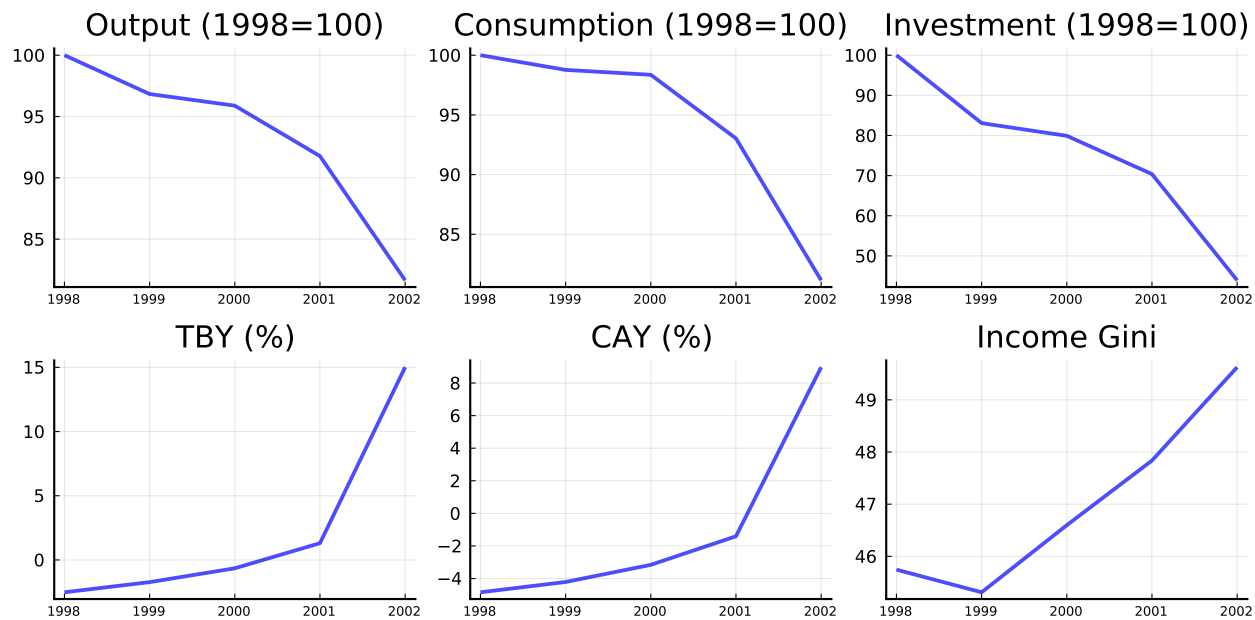
Figure 13 plots a five year window centered around sudden stop events and averaged across all episodes. Each series is HP-filtered with a lambda of 6.25, except for the real exchange rate, which is shown as a percentage deviation from its long-run mean. Output, consumption, and investment are all above the trend two years before a sudden stop crisis. However, when sudden stops occur, output and consumption declines by about 4%, while investment declines by more than 10%. The decline in investment is much more severe, which reflects the stock-flow amplification and is consistent with real business cycle facts. One particular interesting phenomenon is the persistence of the investment series after a crisis. While consumption and output start recovering a year after crises, the investment series implies that it is still about 5% below trend, which was the case at the onset of crises.

External balances, such as the trade balance-to-GDP and the current account-to-GDP, both show a sharp increase during a crisis. Economies in the dataset on average accumulate a trade balance-to-GDP of 1.5% below trend a year before a crisis, but sharply rises to 1% above trend following a crisis. Similarly, the current account-to-GDP is about 1.5% below trend before a crisis, but rises to more than 1.5% above trend during a crisis. Lastly, there is a around a 2% real exchange rate depreciation during a crisis.

8.4 Argentina from 1998 to 2002

This section discusses how macroeconomic variables and income Gini coefficients behaved from 1998 to 2002 in Argentina. Figure 14 plots output, consumption, investment, trade balance-to-output ratio, and current account-to-output ratio. After normalizing 1998 values of output, consumption, and investment to 100, I find that output and consumption declined by more than 15%, and investment declined by more than 50% over the course of 4 years. Current account-to-GDP ratio and the trade balance-to-GDP ratio rose by 15 percentage points respectively. These results are consistent with the previous results which imply a large sudden stop in Argentina from 1998 to 2002. While the focus of distributional impact is not on income Gini coefficient, it is still informative to see how the income inequality over the entire population behaved during this time period. In 1998, the income Gini, calculated from the Permanent Household Survey in my own sample, is approximately 46. The index declines slightly in 1999, but rises quickly from 2000 to 2002.

Figure 14: Argentina Macroeconomic Variables from 1998 to 2002



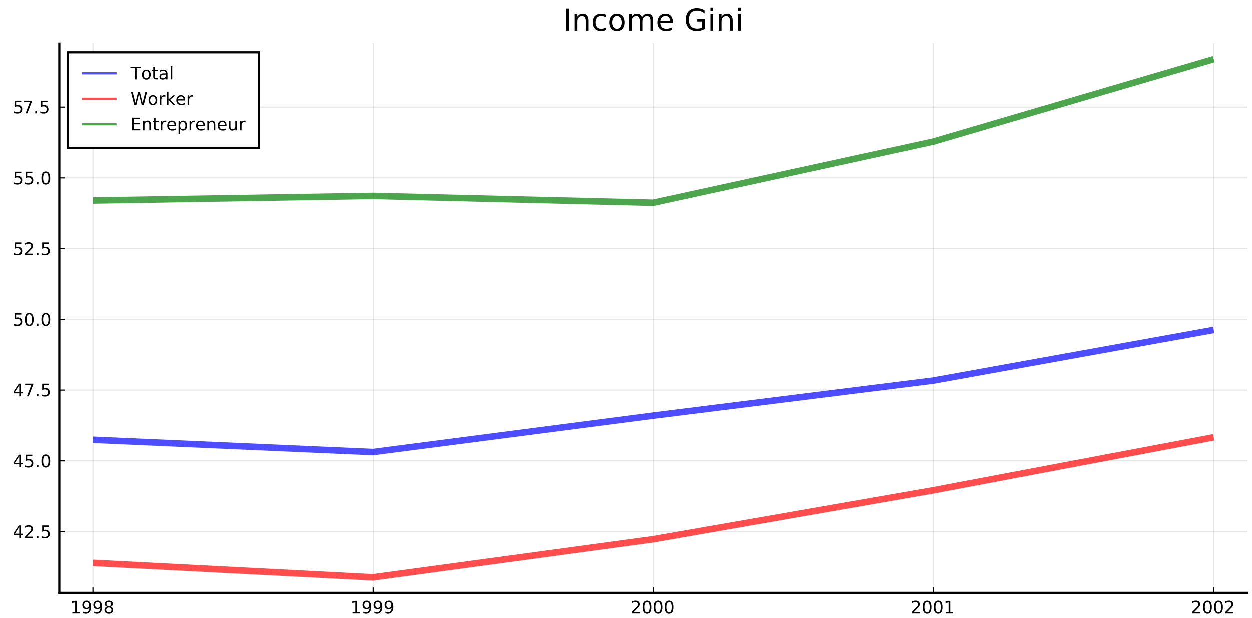
Note: This figure plots output, consumption, investment, trade balance-to-output, current account-to-output, and income Gini coefficient from 1998 to 2002. All data except the Gini is from the World Development Indicators. Income Gini is calculated from the Permanent Household Survey. Output, consumption, and investment are normalized to 100 in 1998 while the current account-to output ratio, trade balance-to-output ratio, and income Gini are raw values.

Figure 15 breaks down the income Gini coefficient into income Gini of workers and income Gini of entrepreneurs. I find two main results. First, overall, entrepreneurial group exhibits higher income inequality over the time period of interest, which is consistent with the takeaways from summary statistics and the population distribution. Second, the rise in income inequality, measured by the slope of each line, is steeper for entrepreneurs. These findings are consistent with the main story that entrepreneurs drive income inequality during sudden stops. However, I focus on average relative income responses across occupations and the income distribution as a measure of distributional impact because there are more variations in the individual levels of incomes rather than looking at income Gini coefficients.

8.5 Empirical Estimation: Groups Only

Consider a DID specification to quantify the heterogeneous income losses across the occupational groups. Let $\ln y_{it}$ be log of total income for an individual i at time t. The initial

Figure 15: Argentina Income Gini from 1998 to 2002



Note: This figure plots income Gini coefficients for entrepreneurs, workers, and the overall population from 1998 to 2002.

estimating equation can be written as

$$\ln y_{it} = \lambda_t + Entre_i + \beta Crisis_t Entre_i + \Gamma X_{it} + \epsilon_{it} \tag{29}$$

where λ_t is a time fixed effect and $Entre_i$ is a dummy variable that equals to 1 when an individual i is an entrepreneur. My coefficient of interest is β, which captures the relative impact of a crisis of an entrepreneur to a worker. Lastly, $Crisis_t$ is equal to 1 when $t > 1998$, which corresponds to the beginning year of a large sudden stop episode identified by the event analysis in the previous section. Simply comparing the average income of entrepreneurs to an average income of worker is not sufficient to capture the heterogeneity fully since there are various systematic differences between individuals that are not captured by the occupation. Therefore, I control for various factors that affect an individual's income such as the sector of occupation, family status (whether one is a head of a household or not), gender, age, location, and education level. This exercise is not meant to provide a causal inference, since the choice to become an entrepreneur is an endogenous choice made by individuals. However, this design allows a comparison of the average income loss between an entrepreneur

Table 6: Income Loss Heterogeneity From Sudden Stops - Between Occupations

	ln(income)	
	(1)	(2)
Post x Entre	-0.141***	-0.235***
	(0.011)	(0.023)
Group	Yes	Yes
Year	Yes	
N	428,660	113,743
R^2	0.373	0.418

Note: This table presents regression results for the coefficient of interest from eq 29. The regression equation is $\ln y_{it} = \lambda_t + Entre_i + \beta Crisis_t Entre_i + \Gamma X_{it} + \epsilon_{it}$. λ_t is a time fixed effect, $Entre_i$ is an entrepreneur dummy, X_{it} is a vector of controls, and β is the main coefficient of interest that captures average relative income loss between an entrepreneur and a worker. Specification (1) uses the full sample from 1996-2003, while (2) only uses 1998 and 2002. (1) implies that entrepreneurs on average lost 12% more income than workers after controlling for various factors. Since (2) looks at the peak-trough income losses, the estimate is larger.

and a non-entrepreneur during a sudden stop, which gives an insight to some distributional implications.

Table 6 displays the estimated result from eq. 29. The first specification uses the full sample from 1996-2003. The regression coefficient can be interpreted as follows: entrepreneurs on average lost 13% more income relative to workers from the sudden stop episode in Argentina. As a robustness check, I also run the regression with only using the samples from the year 1998 and 2002. These two specific years have been chosen because the peak of the crisis occured in the late 2002 with the Argentinian government defaulting on their outstanding debt. Because this specification looks at peak to trough, the relative income loss for entrepreneurs on average is higher at 20%.

I also run the following set of regressions to determine how much occupations by itself help explain average relative income losses.

$$\ln y_{it} = \lambda_t + se_i + \beta Crisis_t se_i + \Gamma X_{it} + \epsilon_{it} \tag{30}$$

$$\ln y_{it} = \lambda_t + emp_i + \beta Crisis_T emp_i + \Gamma X_{it} + \epsilon_{it} \tag{31}$$

where λ_t is a time fixed effect and se_i, emp_i stand for a dummy variable that represents self-employed and employers, respectively. The coefficients of interests would be β which measure

Table 7: Relative Income Loss Between Occupations

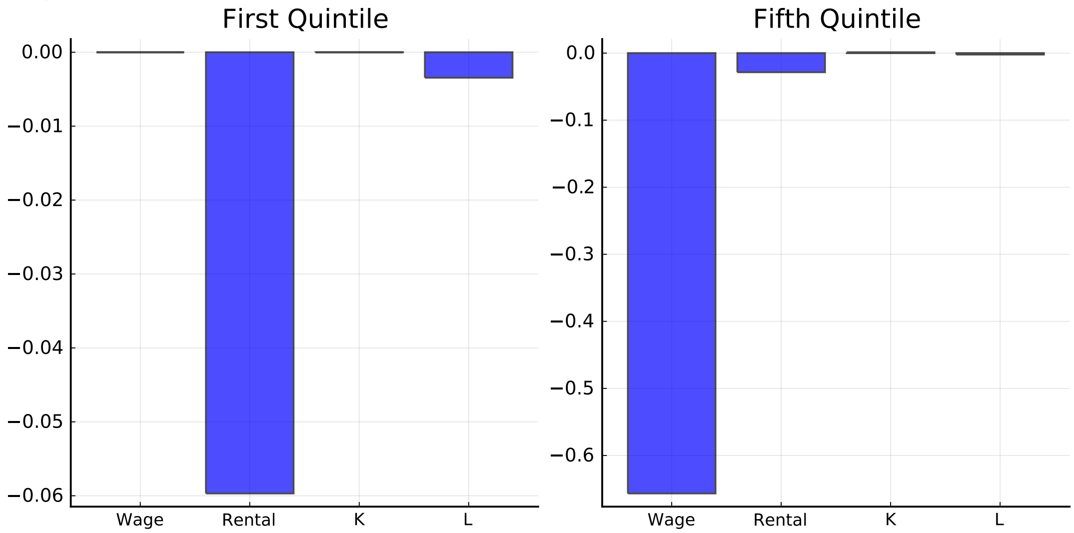
	ln(income)			
	(1)	(2)	(3)	(4)
Post x Entre	-0.146***	-0.109***	-0.226***	-0.210***
	(0.011)	(0.023)	(0.024)	(0.053)
Group	Yes	Yes	Yes	Yes
Year	Yes	Yes		
N	397,725	333,991	105,331	88,793
R^2	0.377	0.397	0.422	0.437

Note: This table presents regression results for the coefficient of interest from eq 29. The regression equation (1) and (3) are $\ln y_{it} = \lambda_t + se_i + \beta Crisis_t se_i + \Gamma X_{it} + \epsilon_{it}$. The regression equation (2) and (4) are $\ln y_{it} = \lambda_t + emp_i + \beta Crisis_t emp_i + \Gamma X_{it} + \epsilon_{it}$. λ_t is a time fixed effect, se_i is an entrepreneur dummy, X_{it} is a vector of controls, and β is the main coefficient of interest that captures average relative income loss between a self-employed (or employer) and a worker. Specification (1) and (2) uses the full sample, while (3) and (4) uses only 1998 and 2002.

the average relative income loss between self-employed and workers as well as employers and workers.

Table 7 shows the regression results for the above specifications. The first column only looks at average relative income loss between self-employed entrepreneurs and workers, which is 14.6%, which is little higher than 14.1% from Table 6, which look at all entrepreneurs. Since most entrepreneurs are self-employed, it is reasonable to see that the coefficient estimates between two specifications are quantitatively close. The second column only looks at employer-entrepreneurs. The coefficient is 11%, which is a lower estimate than the baseline. In both of these cases, there is a larger income loss when looking at the peak-trough periods, which are shown in the third and the fourth columns. Consistent with the main empirical section, the main message that a large part of the income loss is from the self-employed entrepreneurs still holds. However, occupations themselves is not sufficient to explain the heterogeneity in income losses. It is not only the self-employed entrepreneurs, but it is the poor self-employed entrepreneurs. Likewise, it is not only the employer-entrepreneurs, but rich employer-entrepreneurs. This is why one must also take into account the income distribution as well as the occupation when discussing heterogeneity in income losses during sudden stops.

Figure 16: Sources of Variation of Entrepreneur's Income - Factors and Prices



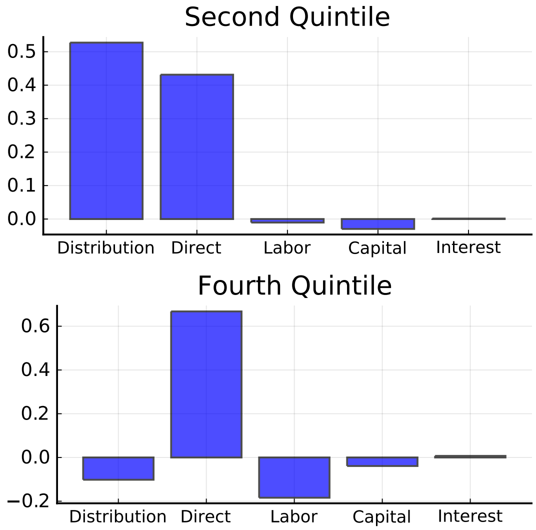
Note: The graph plots the sources of variations for entrepreneur's income in the first and fifth quintiles into wage, labor, rental rate, and capital effects.

8.6 Additional Model Results

This section presents additional results related to the variance decomposition exercises. Figure 16 plots how changes in wage, labor, rental rate, and capital contribute to the volatility of entrepreneur's average incomes in the first and the fifth quintiles. In the first income quintile, I find that movements in the rental rate contributes about 6% of the volatility. Since it is looking at the changes in prices only which affect the cost side of the profit, it is reasonable to assume that it is negatively correlated with the average income. In contrast, I find that wages play a much larger role than any other effects at the top income quintile.

Figure 17 plots the contributions of the extensive, direct, rental-capital, wage-labor, and interest rate effects on the entrepreneur's average income in the second, third, and fourth income quintiles. Most notably, I find that the extensive margin plays smaller roles as I move up the income distribution. The negative correlation of the extensive effects with the average income in the third quintile imply that during sudden stops, the income distribution of entrepreneurs get wider, and they are more likely to move to the lower end of the income distribution. Figure 18 further decomposes effects into the rental rate, wage, capital, and labor. One key takeaway from this figure is that quantities start playing larger

Figure 17: Sources of Variation of Entrepreneur's Income - 2 4th Quintiles



Note: The graph plots the sources of variations for entrepreneur's income in the second, third, and fourth income quintiles into five effects: extensive, direct, rental-capital, wage-labor, and interest rate.

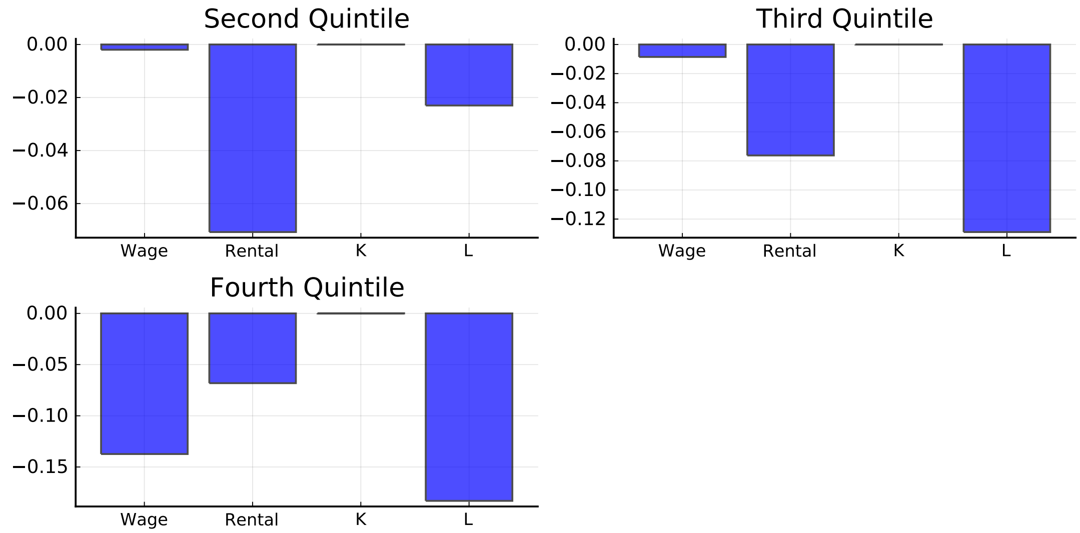
roles as entrepreneurs get richer. However, both movements in factors and prices seem to be negatively correlated with the average entrepreneurial income.

8.6.1 Second Moments

In this section, I report the second moments associated with the model to see how aggregate variables behave along the business cycle. Particularly, the model hopes to capture two important facts: i) the excess consumption volatility relative to output and ii.) the countercyclicality of external balances (current account and trade balance). To see how the introduction of occupational choice affect aggregate dynamics, I also solve a version of the model without entrepreneurs. Table 8 present the second moments from the data, the baseline model, and the model without entrepreneurs. There are two main differences between the baseline model and the model without entrepreneurs. First, the model without entrepreneurs imply lower consumption volatilities. Second, it implies a procyclical trade balance-to-GDP ratio and an almost acylical current account to GDP ratio.

In the data, the relative consumption volatility over output volatility is 1.08, whereas the baseline model implies a slightly higher consumption to output volatility of 1.30. The model without entrepreneurs displays a lower consumption to output volatility of 0.98. The addi-

Figure 18: Sources of Variation of Entrepreneur's Income - 2 4th Quintiles - Factors and Prices



Note: The graph plots the sources of variations for entrepreneur's income in the second, third, and fourth quintiles into wage, labor, rental rate, and capital effects.

tional endogenous movements in prices and factors amplify income responses of entrepreneurs and lead to higher volatilities of consumption at the micro level. Furthermore, the correlation between GDP and trade balance-to-GDP is -0.79 and the correlation between GDP and current account-to-GDP is -0.71 in the data. The baseline model predicts the correlation between GDP and trade balance (current account) to be -0.52 (-0.64). On the other hand, the model without entrepreneurs predicts a procyclical trade balance-to-GDP and an acyclical current account-to-GDP. Why is the current account-to-GDP countercyclical in the model whereas the model without entrepreneurs is acylical? Recall that the definition of external savings is the difference between the total domestic savings and total domestic investment. In response to a drop in the aggregate GDP, the baseline model implies that the total external savings in this economy rise relative to the previous period. Meanwhile, the acyclicality of the current account in the model without entrepreneurs imply that either domestic savings rises less and/or domestic investment decreases more relative to the changes in the baseline model. During a recession, the aggregate productivity drops while interest rate premium rises. In the baseline model, this incentivizes entrepreneurships along the income distribution. Poorer workers become self-employed entrepreneurs due to the fall in wages and labor

Table 8: Second Moments

Variable	$\sigma(x)$ Data	Baseline	Worker	$\rho(x_t, x_{t-1})$ Data	Baseline	Worker	$\rho(x, y)$ Data	Baseline	Worker
Output	7.63	7.68	7.09	0.7	0.66	0.71	1.0	1.0	1.0
Consumption	8.26	10.01	7.90	0.69	0.53	0.95	0.97	0.90	0.01
Investment	20.19	20.07	17.90	0.54	0.85	0.79	0.95	0.63	0.53
Trade balance-to-GDP	3.45	3.40	10.16	0.51	0.62	0.83	-0.79	-0.56	0.58
Current account-to-GDP	2.8	2.22	13.05	0.51	0.53	0.80	-0.71	-0.80	-0.03

Note: This table reports theoretical second moments of the baseline model. Output, consumption, investment, and income Gini are in percentage deviations from the steady state. Trade balance-to-GDP, and current account-to-GDP are in level deviations from the steady state. Moments from data are quadratically filtered.

demand. Rich workers become employer-entrepreneurs because they are more likely to accumulate savings which incentivizes employer-entrepreneurship. Pursuing entrepreneurship in the baseline model require capital and assets to operate their own businesses, which lead to a larger rise, relatively speaking, in the aggregate capital and savings.

8.6.2 Setting with a Capital Tax

Imposing a capital tax implies that one can rewrite the budget constraints for households with an idiosyncratic state s as follows.

$$c_t^i(s,S) + a_{t+1}^i(s,S) = a_t(s,S) + y_t^i(s,S) \tag{32}$$

$$y_t^i(s,S) = \begin{cases} w_t(S)\bar{h}^w\epsilon_t + (1-\tau)r_t(S)a_t & i = w \\ \pi_t^{se}(s,S) + (1-\tau)r_t(S)a_t & i = se \\ \pi_t^{em}(s,S) + (1-\tau)r_t(S)a_t & i = em \end{cases} \tag{33}$$

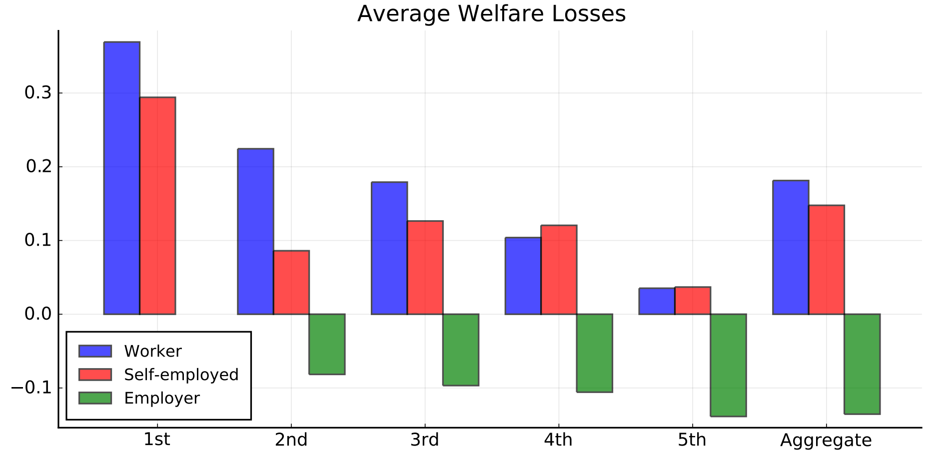
where y_t^i is the income for occupation $i = (w, se, em)$, and $\tau > 0$ represents capital controls. Profit functions for self-employed and employer-entrepreneurs can be re-written as follows.

$$\pi_t^{se}(s,S) = z\xi\theta(k_t(s,S)^\alpha h_t(s,S)^{1-\alpha})^{\nu^{se}} - (1+\tau)(u_t(S)+m)k_t(s,S) \tag{34}$$

$$\pi_t^{em}(s,S) = z\theta(k_t(s,S)^\alpha l_t(s,S)^{1-\alpha})^{\nu} - (1+\tau)u_t(S)k_t(s,S) - w_t(S)l(s,S) - (1+r_t(S))\kappa \tag{35}$$

Figure 19 plots average welfare losses when the revenue from capital taxation is given

Figure 19: Average Welfare Losses from a Capital Tax with Transfers: Long-Run



Note: This figure plots the average long-run welfare losses from a capital tax that are given back to households as a lump-sum transfer across the income distribution and by occupation. Welfare is expressed as a percentage of consumption.

back to households in a lump-sum fashion. In this case, there is some redistribution even in the long run. Particularly, there are significant welfare gains for workers and self-employed entrepreneurs while there are welfare losses for employer entrepreneurs.