Working and Saving Informally

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Presentation Plan

Introduction

Model Estimation

Counterfactual experiments

Concluding remarks and next steps

Introduction

Motivation

- Informality is a salient feature in developing economies (La Porta and Shleifer, 2014).
  - In LAC the informal sector represents 41.1% of the GDP and employs between 30 and 80% of the total employment (Gasparini and Tornarolli, 2009).
- Another well-known characteristic of the developing world is the low rate of savings.
  - In LAC, gross domestic savings represent only 17% of the GDP (in high income countries this figure is around 30%).
- The theoretical and empirical literature that independently analyzes the causes and consequences of these two phenomena is vast.
  - The link between informality and savings in developing countries has been less studied and the empirical literature focus on informality $\rightarrow$ savings.
  - Exceptions are Granda and Hamann (2015), Flórez (2017), Esteban-Pretel and Kitao (2022).

This Paper

This paper is a contribution to the recent literature by recognizing the fundamental links between the two phenomena.

- We develop a labor market model where workers can be employed both formally and informally and where agents can save through both formal and informal financial institutions.
- We estimate the model using information of household surveys for Colombia and perform counterfactual simulations to analyze the effect of policy changes.

Questions

1. What is the effect of financial exclusion on savings, informality and inequality?
2. What is the role of informality in inducing/preventing precautionary savings under financial exclusion?

Model Estimation

Workers' optimization problem

The model environment can be summarized in the following optimization problem:

$$
\begin{aligned}
\max_{c,\phi} \quad & E_0 \int_0^{\infty} e^{-(\rho+\theta)t} \frac{c^{\delta}}{\delta} \\
s.t. \quad & da = \left[(r_1\phi + r_2(1-\phi))a + i - c - \frac{\psi(f)}{2}\phi^2 \right] dt \\
& a \geq 0 \\
& dr_2 = \kappa(\bar{r}_2 - r_2)dt + \sigma dz \qquad r_2 \sim \mathcal{N}\left(\bar{r}_2, \frac{\sigma^2}{2\kappa}\right) \\
& di = \begin{cases} dq_{\lambda_1^u} \mathbb{I}_1 w(1) + dq_{\lambda_0^u} \mathbb{I}_0 w(0) - b & u \\ dq_{\eta_1} b + dq_{\lambda_1^e} \mathbb{I}_1 w'(1) + dq_{\lambda_0^e} \mathbb{I}_0 w'(0) - w(1) & f = 1 \\ dq_{\eta_0} b + dq_{\lambda_1^e} \mathbb{I}_1 w'(1) + dq_{\lambda_0^e} \mathbb{I}_0 w'(0) - w(0) & f = 0 \end{cases}
\end{aligned}
$$

where $w(f)$ are draws form $F(w|f)$ and f are a draws from a Bernoulli distribution with $p(f)$.

Data Description

Gran Encuesta Integrada de Hogares (GEIH): Monthly household survey focused on labor market outcomes

- Individual characteristics (gender, age, years of schooling)
- Labor market states (non-employment, formal and informal employment)
- Retrospective information on labor market states (yearly transitions).
- Labor income and weekly hours worked.

Encuesta Longitudinal Colombiana (ELCA): Longitudinal survey that follows $\approx$ 10000 households every three years (2010, 2013, and 2016).

- Savings behavior (average monthly savings, formal savings and informal savings.

Sample: male, head of households, between 25 and 65 years old, living in urban areas, and without a College degree ("unskilled").

Descriptive Statistics of the Labor Market

Table 1: Descriptive Statistics

	Non-Employment	Formal Employment	Informal Employment
Labor Market States			
Proportion	0.151	0.361	0.488
Wages (hundred of US$ of 2016 per month)			
Mean	–	3.420	2.632
Standard Deviation	–	1.524	1.246
Labor Market Yearly Transitions (row=from, col=to)			
Non-Employment	0.075	0.027	0.032
Formal Employment	–	0.287	–
Informal Employment	–	–	0.400
Employment	0.074	0.049	0.056
Savings (hundred of US$ of 2016 per month)			
Mean	0.483	0.561	0.588
Standard Deviation	0.447	0.549	0.791
Individuals who save			
Proportion	0.083	0.271	0.186
Individuals who's assets are mostly in formal financial institutions			
Proportion	0.214	0.453	0.270

Estimation and identification

- We estimate the model using the Method of Simulated Moments (MSM).
- Identification:
  - Interest rate in the informal financial system: We assume the 99% interval $[0, 0.075 \times 2.1]$, therefore $\mathcal{N}\left(0.079, \frac{\sigma^2}{2\kappa} = 0.0009\right)$ (Eeckhout and Munshi, 2010)
  - Labor market dynamics: transitions (Flinn and Heckman ,1982).
  - Wages distributions and unemployment income: Log-normality assumption and the observed wages (Flinn and Heckman, 1982).
  - Portfolio costs: Observed savings and the behavior of individual in choosing financial assets to accumulate wealth.
- Estimation takeaways:
  - Informal workers face significantly higher portfolio costs of formal financial assets.
  - Workers' transits between formal and informal jobs with some frequency so that the formality state is not a permanent state.

Counterfactual experiments

Definitions

We perform two sets of counterfactual experiments:

- *Full inclusion of informal workers into the formal financial system*: equal portfolio costs.
- *Labor market policies that reduce informality*: Proportion of informal job offers drops from the baseline 72% to 20%.

We evaluate the impact on labor market and financial outcomes and on wealth and consumption inequality.

Results

Table 2: Counterfactual Experiments I

	Benchmark	Financial Inclusion $\psi^e(0) = \psi^e(1) = 0.024$		Lower LM Informality $p(0) = 0.2$	
	Value	Value	Ratio	Value	Ratio
Labor market states					
u	0.157	0.158	1.003	0.134	0.851
$e(1)$	0.348	0.345	0.992	0.765	2.198
$e(0)$	0.495	0.497	1.005	0.102	0.205
Wages					
$E[w\|e(1)]$	3.643	3.618	0.993	3.723	1.022
$E[w\|e(0)]$	2.596	2.628	1.012	2.607	1.004
$E[w\|e(1)]/E[w\|e(0)]$	1.403	1.377	0.981	1.428	1.018
Savings					
$E[s]$	0.113	0.122	1.071	0.121	1.068
$E[s\|e(1)]$	0.182	0.182	1.000	0.188	1.037
$E[s\|e(0)]$	0.205	0.226	1.105	0.207	1.011

NOTE: Benchmark's values are: $\psi^e(0) = 0.174; \psi^e(1) = 0.024; p(0) = 0.72$. Results are based on simulations of 10.000 individuals.

Table 3: Counterfactual Experiments II

	Benchmark	Financial Inclusion $\psi^e(0) = \psi^e(1) = 0.024$		Lower LM Informality $p(0) = 0.2$	
	Value	Value	Ratio	Value	Ratio
Assets in Formal Institutions					
$E[\phi a]$	3.462	4.104	1.186	4.174	1.206
$E[\phi a \mid e(1)]$	5.208	5.238	1.006	4.883	0.938
$E[\phi a \mid e(0)]$	2.852	4.166	1.461	2.514	0.881
Total Assets					
$E[a]$	8.650	8.681	1.004	8.945	1.034
$E[a \mid e(1)]$	11.011	10.789	0.980	10.204	0.927
$E[a \mid e(0)]$	8.715	8.880	1.019	7.709	0.885
Inequality (Theil Index)					
a	0.330	0.327	0.991	0.275	0.833
ϕa	0.581	0.450	0.775	0.413	0.710
c	0.204	0.201	0.984	0.169	0.830

NOTE: Benchmark's values are: $\psi^e(0) = 0.174; \psi^e(1) = 0.024; p(0) = 0.72$. Results are based on simulations of 10.000 individuals.

Concluding remarks and next steps

Concluding Remarks

- Workers in many low- and middle-income countries are characterized by high probability to work informally and they have low savings, frequently allocated outside formal financial institutions.
- We develop an environment able to integrate the behaviors leading to both phenomena.
- We use data from Colombia to estimate the model that are complete enough to characterize both labor market and saving behaviors.
- Estimation results show that informal workers face higher costs of saving in formal financial assets and that formality state is not a permanent state of a typical individual labor market career.

Concluding Remarks

- We perform two counterfactual experiments using the estimated model so as to evaluate policy changes in an equilibrium setting.
- Financial inclusion of informal workers result in a significant increase in the informal and the overall saving rate.
- A massive reduction of the proportion of informal job offers is able to just barely generate a saving rate similar to the one obtained with full financial inclusion.
- Full financial inclusion slightly decreases inequality in consumption and in formal assets but less so than the labor market policy.

Next Steps

We are working in improving some limitations of the current model environment.

- Utility value of working formally in a similar fashion of Dey and Flinn (2008) and Conti et.al. (2018):

$$E_0 \int_0^{\infty} e^{-\tilde{\rho} t} \left[u(c) + \epsilon f \right]$$

  where ϵ is a non-negative scalar and f is an indicator variable that takes the value of 1 if the individual is working formally and 0 otherwise.

- Additional policy variable: pay-roll tax paid only by individual who are working formally. $w(f)(1 - \tau f)$

- Possibility of borrowing from formal and informal financial institutions while maintaining the incomplete markets assumption.

$$a \geq \underline{a} = -b / r_2^{\max}$$

Thank You!!

Additional slides

Literature

- Informality:
  - Albrecht et al. (2009), Bosch and Esteban-Pretel (2012), Charlot et al. (2013) and Bobba et al. (2018) in a DMP type setting.
  - Meghir et al. (2015) in a Burdett-Mortensen type setting.
- Optimal savings with heterogeneous agents:
  - Huggett (1993), Aiyagari (1994) and Krussel and Smith (1998) are classic macro papers. Achdou et.al. (2017) revisited this literature in continous time.
  - Krusell et al. (2010) introduces savings in a DMP setting and Bayer and Walde (2010) does it in continuous time.
  - Rendon (2006) and Lise (2013) introduces savings in a partial equilibrium search models.
- Structural estimation:
  - Flinn and Heckman (1986) and Flinn (2002) estimation of partial equilibrium search models with labor market information.
  - Rendon (2006) and Lise (2013) estimate their model incorporating also data on assets.

Value Functions

The steady state value of unemployment is:

$$\tilde{\rho}U(a,r_2) = \max_{0\le c\le\bar{c},0\le\phi\le 1}\left\{u(c)+\partial_a U(a,r_2)\left[(r_1\phi+r_2(1-\phi))a+b-c-\frac{\psi^u}{2}\phi^2\right]\right.$$
$$+\partial_{r_2}U(a,r_2)\kappa(\bar{r}_2-r_2)+\frac{1}{2}\partial^2_{r_2}U(a,r_2)\sigma^2$$
$$\left.+\lambda^u\sum_{f=0}^{1}\left(\int_w \max\{W(a,r_2,w,f)-U(a,r_2),0\}dF(w|f)p(f)\right)\right\}$$

The steady state value of employment is:

$$\tilde{\rho}W(a,r_2,w,f) = \max_{0\le c\le\bar{c},0\le\phi\le 1}\{u(c)+\epsilon f+\partial_a W(a,f)\left[(r_1\phi+r_2(1-\phi))a\right.$$
$$\left.+b-c-\frac{\psi^e(f)}{2}\phi^2\right]+\partial_{r_2}W(a,r_2,w,f)\kappa(\bar{r}_2-r_2)$$
$$+\frac{1}{2}\partial^2_{r_2}W(a,r_2,w,f)\sigma^2+\delta(f)\left[U(a,r_2)-W(a,r_2,w,f)\right]$$
$$+\lambda^e\sum_{f=0}^{1}\left(\int_{w'}\max\{W(a,r_2,w',f')-W(a,r_2,w,f),0\}dF(w'|f')p(f')\right)$$

Solution Method

- Optimal decisions of consumption are characterized by:

$$c^u(a, r_2) = u'^{-1}(\partial_a U(a, r_2))$$
$$c^e(a, r_2, w, f) = u'^{-1}(\partial_a W(a, r_2, w, f))$$

  while the optimal portfolio allocation by:

$$\phi^u(a, r_2) = \frac{(r_1 - r_2)a}{\psi^u} \in [0, 1]$$
$$\phi^e(a, r_2, f) = = \frac{(r_1 - r_2)a}{\psi^e(f)} \in [0, 1]$$

- We use a two-step approach to solve for the steady state equilibrium of the model.
  1. Hamilton-Jacobi-Bellman equations: value function iteration and finite difference with an upwind scheme to approximate the derivatives of the value functions (Achdou et al., 2014, 2017).
  2. Kolmogorov Forward equations: simulation approach to compute the invariant distributions of labor market states and of total assets.

Solution Method

- Value functions iteration with a discretized state space and an upwind finite difference method to approximate the derivatives (Achdou et.al., 2017).
- Define $W_{i,j,k,f}$ and $U_{i,j}$ for the grids a_i, $r_{2,j}$, w_k.

$$\partial_a U(a, r_2) \approx \begin{cases} \frac{U_{i+1,j} - U_{i,j}}{a_{i+1} - a_i} & da > 0 \\ \frac{U_{i,j} - U_{i-1,j}}{a_i - a_{i-1}} & da < 0 \end{cases}$$

$$\partial_a W(a, r_2, w, f) \approx \begin{cases} \frac{W_{i+1,j,k,f} - W_{i,j,k,f}}{a_{i+1} - a_i} & da > 0 \\ \frac{W_{i,j,k,f} - W_{i-1,j,k,f}}{a_i - a_{i-1}} & da < 0 \end{cases}$$

- Upwind to approximation $\partial_a U(a, r_2)$ and $\partial_a W(a, r_2, w, f)$
- The upwind approximation $\partial^2_{r_2} U(a, r_2)$ and $\partial_{r_2} W(a, r_2, w, f)$ is similar, use *forward difference* when $dr_2 > 0$ and *backward difference* when $dr_2 < 0$.

Solution Method

- We use again finite differences to approximate the second derivative.

$$\partial^2_{r_2} U(a, r_2) \approx \frac{U_{i,j+1} - 2U_{i,j} + U_{i,j-1}}{(r_{2,j+1} - r_{2,j})^2}$$

$$\partial^2_{r_2} W(a, r_2, w, f) \approx \frac{W_{i,j+1,k,f} - 2W_{i,j,k,f} + W_{i,j-1,k,f}}{(r_{2,j+1} - r_{2,j})^2}$$

- Boundary conditions in a-dimension are needed for the backward approximation:

$$\begin{aligned}\partial_a U(\underline{a}, r_2) &= u'(r_1\phi(\underline{a}, r_2, 0) + r_2(1 - \phi(\underline{a}, r_2, 0)))\underline{a} + b - c^u(\underline{a}, r_2) \\ &\quad - \frac{\psi^u}{2}\phi(\underline{a}, r_2, 0)^2) \\ \partial_a W(\underline{a}, r_2, w, f) &= u'(r_1\phi(\underline{a}, r_2, w, f) + r_2(1 - \phi(\underline{a}, r_2, w, f)))\underline{a} + w - c^u(\underline{a}, r_2, w, f \\ &\quad - \frac{\psi^e(f)}{2}\phi(\underline{a}, r_2, w, f)^2)\end{aligned}$$

- Boundary conditions in r_2-dimension:

$$\partial_{r_2} U(a, \underline{r_2}) = 0 \Rightarrow U_{i,0} = U_{i,1}$$
$$\partial_{r_2} U(a, \bar{r}_2) = 0 \Rightarrow U_{i,J+1} = U_{i,J}$$
$$\partial_{r_2} W(a, \underline{r_2}, w, f) = 0 \Rightarrow W_{i,0,k,f} = W_{i,1,k,f}$$
$$\partial^2_{r_2} W(a, \bar{r}_2, w, f) = 0 \Rightarrow W_{i,J+1,k,f} = W_{i,J,k,f}$$

Estimation Results

Table 4: Labor Market Parameters

Definition	Parameter	Est. Value	Std. Error
Mobility			
Job offer rate - non-employment	λ^u	0.168	(0.03598)
Job offer rate - formal employment	$\lambda^e(1)$	0.023	(0.00921)
Job offer rate - informal employment	$\lambda^e(0)$	0.030	(0.00673)
Job separation rate - formal employment	$\eta(1)$	0.027	(0.00275)
Job separation rate - informal employment	$\eta(0)$	0.049	(0.00712)
Job Offers Distributions			
Proportion of formal jobs	$p(1)$	0.280	(0.01020)
Mean of wages distribution - formal employment	$\mu(1)$	1.190	(0.01005)
Std.Dev. of wages distribution - formal employment	$\sigma(1)$	0.350	(0.00671)
Mean of wages distribution - informal employment	$\mu(0)$	0.742	(0.01286)
Std. Dev. of wages distribution - informal employment	$\sigma(0)$	0.481	(0.01498)

NOTE: Bootstrap standard errors in parentheses.

Estimation Results

Table 5: Financial Parameters

Definition	Parameter	Est. Value	Std. Error
Portfolio Adjustment Cost			
Adjustment cost - non-employment	ψ^u	0.023	(0.00572)
Adjustment cost - formal employment	$\psi^e(1)$	0.024	(0.00504)
Adjustment cost - informal employment	$\psi^e(0)$	0.174	(0.03599)
Informal Assets Returns Process			
Persistence of the rate	κ	0.683	(0.01657)
Standard Deviation of the shock	σ	0.036	(0.02562)
Non-employment Income			
Flow value	b	0.220	(0.05350)

NOTE: Bootstrap standard errors in parentheses.

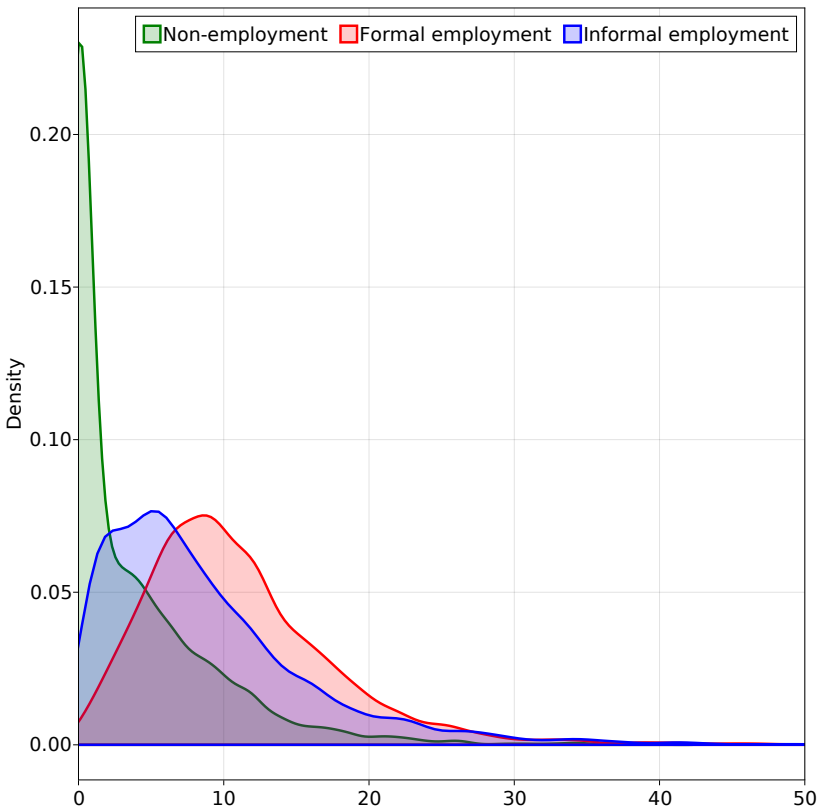
Fit of the Model

Table 6: Moments Fit

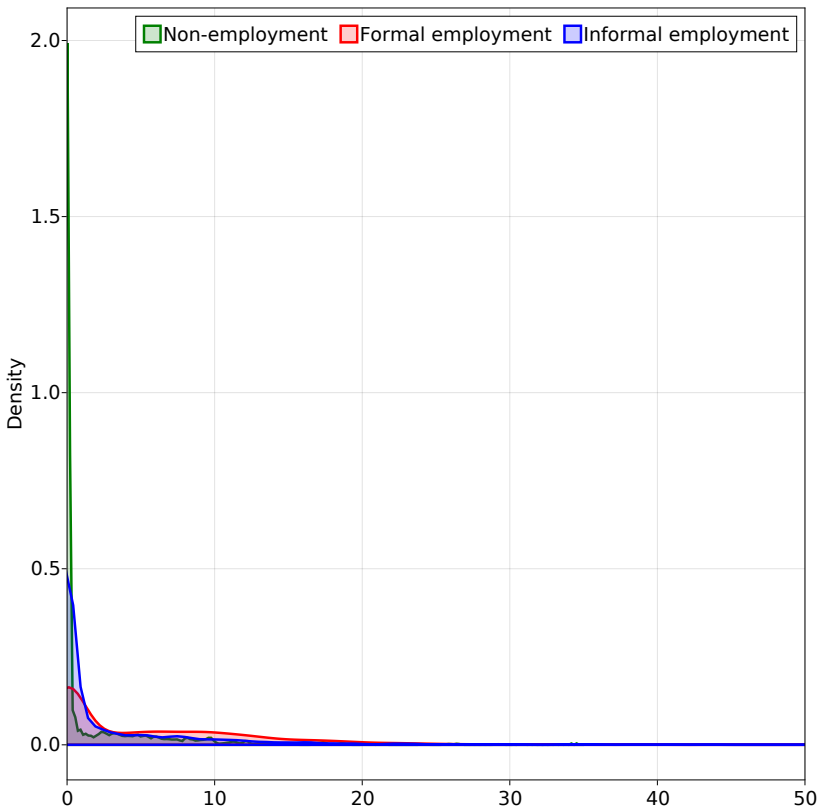
	Data	Model		Data	Model
u	0.151	0.157	$\Pr[e \to u]$	0.074	0.014
$e(1)$	0.361	0.348	$\Pr[e \to e(1)]$	0.049	0.002
$e(2)$	0.488	0.495	$\Pr[e \to e(0)]$	0.056	0.004
$E[w(1)]$	3.420	3.643	$\Pr[\phi > 0.5 \mid u]$	0.214	0.241
$SD[w(1)]$	1.524	1.273	$\Pr[\phi > 0.5 \mid e(1)]$	0.453	0.470
$E[w(0)]$	2.632	2.596	$\Pr[\phi > 0.5 \mid e(0)]$	0.270	0.246
$SD[w(0)]$	1.246	1.287	$E[I_{s>0} \times s \mid u]$	0.040	0.000
$P5[w(1)]$	2.287	2.028	$SD[I_{s>0} \times s \mid u]$	0.183	0.000
$P5[w(0)]$	1.001	1.068	$E[I_{s>0} \times s \mid e(1)]$	0.152	0.220
$\Pr[u \to u]$	0.075	0.143	$SD[I_{s>0} \times s \mid e(1)]$	0.379	0.360
$\Pr[u \to e(1)]$	0.027	0.007	$E[I_{s>0} \times s \mid e(0)]$	0.110	0.239
$\Pr[u \to e(0)]$	0.032	0.020	$SD[I_{s>0} \times s \mid e(0)]$	0.410	0.378
$\Pr[e(1) \to e(1) \mid \textit{same job}]$	0.287	0.339			
$\Pr[e(0) \to e(0) \mid \textit{same job}]$	0.400	0.471			

NOTE: $s = da/dt$ is the amount saved and $I_{s>0}$ is an indicator variable that takes the value of 1 if the individual saves a positive amount and zero otherwise.

Steady State Distributions

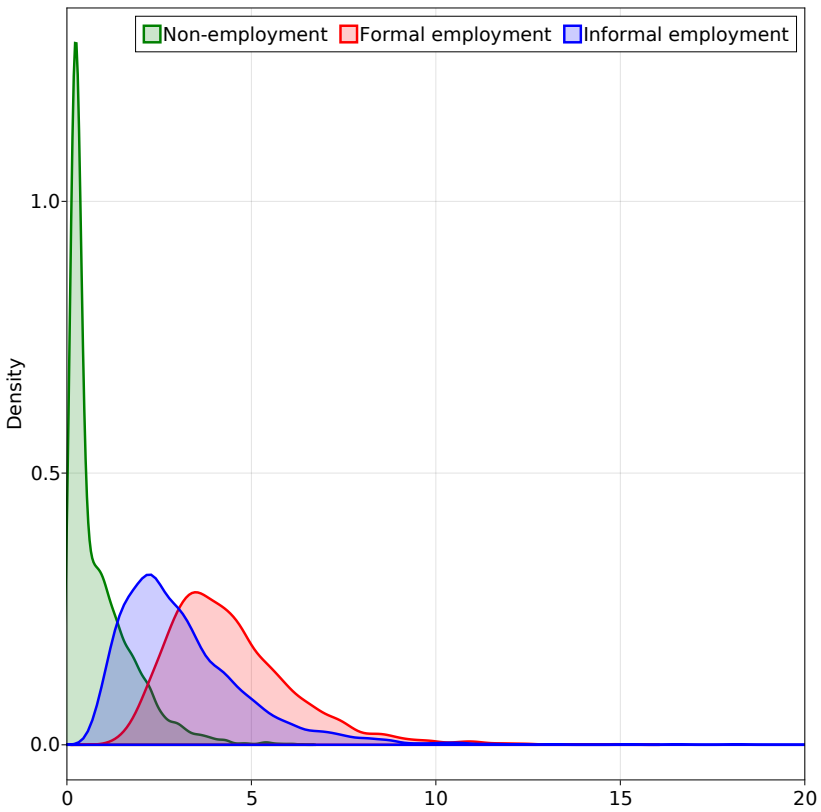


(a) Total Assets

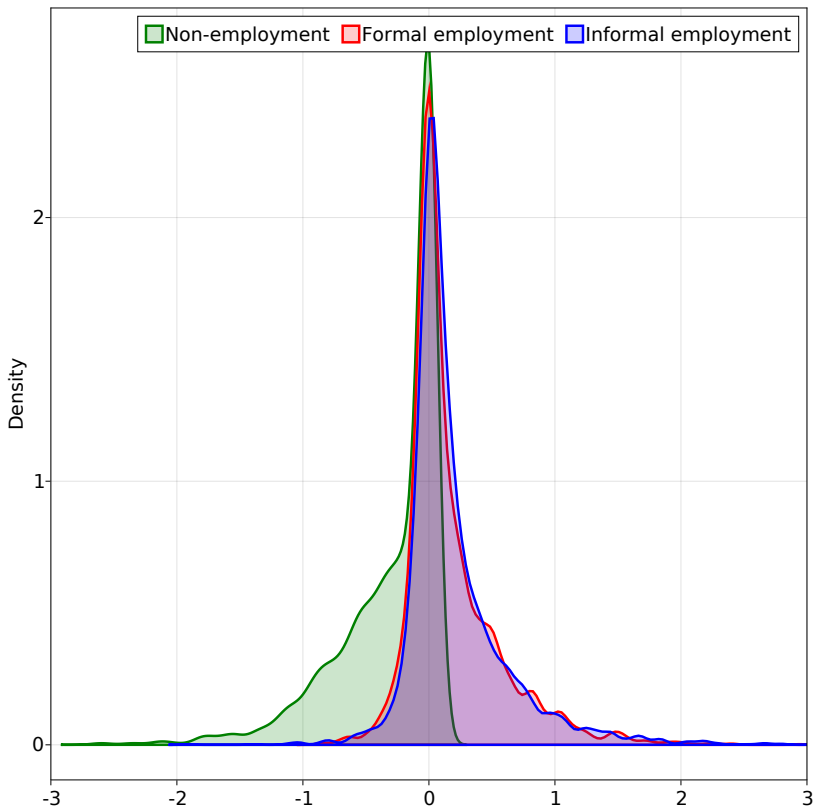


(b) Financial Assets

Steady State Distributions



(c) Consumption



(d) Savings