Universal Basic Income for Developing Economies*

Please click here for the latest version

Kuldeep Singh†

November 6, 2023

Abstract

Universal Basic Income (UBI) has gained traction as an anti-poverty policy for developing economies, but financing it poses challenges due to the vast informal sector that remains outside the income tax net. This paper analyzes the feasibility of financing UBI under alternative financing schemes and studies the long-term aggregate and distributional effects of UBI in developing countries. I build a general equilibrium life cycle model with incomplete markets that incorporates the decision to work in either the formal or informal sector. After calibrating it to Indian data, I find that a UBI equal to half the international poverty line cannot be financed through labor income taxes. An increase in labor income tax shrinks the formal sector, decreases labor supply and reduces human capital accumulation, ultimately leading to reduced tax revenues. Financing UBI via consumption taxes is feasible but results in lower output, capital, and aggregate labor, as well as an increase in income and wealth inequality. Nevertheless, both poor and rich prefer the policy, albeit for different reasons. Finally, I highlight that UBI and taxes have opposing effects on the size of the formal sector.

Keywords: Universal basic income, Developing Country, Informality

JEL Codes: H30, I38, J24, O11, O17

*I am grateful to my dissertation advisors Yongseok Shin, Paco Buera and Ping Wang for their help and guidance throughout this project. I am also thankful to Diego Daruich, the participants of internal seminars, and the reading group at Washington University in St. Louis for their comments and feedback.

†Department of Economics, Washington University in St. Louis, Campus Box 1208, One Brookings Drive, St. Louis, MO 63130. Email: singh.kuldeep@wustl.edu.

1 Introduction

Eradication of poverty remains a major challenge for many governments worldwide. There are various social assistance programs for the poor throughout the world (Banerjee, Hanna, et al. 2022). The mixed evidence on previous anti-poverty policies, difficulties in targeting the poor, and inefficiencies in the government programs has called for unconventional policies to fight poverty in developing countries. One such policy that has drawn more attention in recent years is Universal Basic Income[1] (UBI), a cash transfer given to everyone unconditionally every period.

Obtaining long-term empirical evidence that accounts for both the potential benefits and the costs of UBI is impractical. Additionally, for developing economies, meeting the financial requirements of a UBI presents challenges that significantly differ from those in the developed world. Specifically, the presence of large informal sector reduces the tax capacity (Jensen 2022). Funding UBI through either income taxes or indirect consumption taxes affects individuals' decisions across multiple dimensions, including participation in the formal sector. These decisions, in turn, influence the tax base and other macro variables. Therefore, understanding these interactions becomes important.

My paper addresses the following questions: Can developing countries with a large informal sector feasibly finance UBI through either labor taxes or consumption taxes? What are the long-term aggregate and distributional impacts of such a policy?

To do so, I develop a heterogeneous agents life cycle model with credit constraints and an imperfect insurance market. In this model, individuals are born with initial assets and accumulate human capital during childhood. Subsequently, they face the decision of entering either the formal or informal sector. The formal sector has higher productivity and hence higher earnings. However, entering formal sector entails paying labor income taxes and incurring direct entry costs. In either sector, they choose labor supply subject to wage fluctuations. Additionally, they choose how much to save for precautionary purposes and retirement. Finally, they retire from the labor market, relying on their savings for consumption until they pass away and exit the economy.

The model encompasses most of the benefits and costs associated with UBI. On the positive side, UBI aids credit-constrained individuals in accumulating human capital and in consumption smoothing. Conversely, funding UBI introduces tax distortions, which can undermine these positive effects. Additionally, there is a pure income effect that reduces labor supply, a major concern for policymakers. The overall outcome in the aggregate depends on the interplay between these benefits and costs, as well as the general equilibrium effects.

The stationary equilibrium of the model is calibrated to the Indian economy. To discipline the model, I use both micro and macro data. For individual-level data, I utilize the India Human Development Survey (IHDS) panel from 2005 and 2012 and the National Sample Survey (NSS) 71st Round from 2014. For macro aggregates, I refer to various Indian government ministries. After calibrating the model, I validate the formal-informal sector elasticity implied by the model with experimental evidence from Abel et al. 2022. The model performs well in matching the targeted moments, and the elasticity it implies is within the range derived from experimental evidence.

[1]See, for example, Banerjee, Niehaus, and Suri 2019; Gentilini et al. 2019.

In the benchmark experiment, I propose a UBI set at half the international poverty line. To maintain a balanced government budget, this UBI would be financed through additional taxes and by reallocating funds from other welfare programs that would be replaced by UBI.

I find that financing this level of UBI solely through labor taxes is not feasible. The primary reason is that these taxes are borne exclusively by formal sector workers, and their subsequent response renders this option unviable. I use a linear tax function with one break-point. Everyone above a certain income level is taxed at a constant rate, while those below are exempted. To explore this financing method, I conduct two experiments. First, I increase the labor tax rate without changing exemption level. Next, I decrease the income exemption level without adjusting the labor tax rate.

In the former scenario, agents decrease human capital accumulation and labor supply in order to qualify for higher tax deductions, with minimal changes in formal sector participation. In the latter scenario, where the tax deduction break point is reduced for a given tax rate, the most significant adjustment occurs in the decision to join the informal sector. The formal sector shrinks notably in the long run under this approach. This shift is driven by the fact that reduced tax deductions make the formal sector less attractive to potential participants. Neither approach succeeds in raising the required funds.

An alternative way for financing UBI would be to increase consumption taxes on everyone. I find that it's possible to fund the UBI by raising the consumption tax rate. The final rate increases to 25%, up from the baseline rates of 12% for the informal sector and 18% for the formal sector. However, in the long run, output, capital, and aggregate labor fall. The capital supply falls as a result of a decrease in precautionary and retirement savings. This also leads to an increase in the interest rate and a decline in the effective wage rate. Furthermore, I highlight how UBI contributes to a decrease in labor supply and reduces human capital accumulation among young, primarily because they allocate a significant portion of the UBI transfer to consumption.

Moreover, income inequality, as measured by the Gini coefficient, increases. I argue that the higher labor supply reduction by the workers from the informal sector is responsible for increased income inequality. An increase in income inequality, plus the substantial drop in precautionary savings from the poorer agents, leads to an increase in wealth inequality as well. Yet, despite these adverse effects, both the rich and the poor are in favor of the UBI policy. The poor benefit from enhanced consumption smoothing, while the rich benefit from the resulting higher interest rate in the presence of UBI, which boosts their consumption.

I also emphasize the role of UBI and increased taxes in influencing the size of the formal sector. To fund UBI, initial consumption subsidies for the informal sector are removed, and consumption tax rates also increase. This makes the informal sector less appealing. Nevertheless, with the introduction of UBI, the marginal agent, who was indifferent between the two sectors in the initial equilibrium, shifts to the informal sector. This is because leisure is more affordable in the informal sector. Thus, he can purchase more consumption goods and enjoy more leisure with the UBI in the informal sector than he could in the formal sector. This leads to an increase in the share of the informal sector.

Finally, I discuss the significantly different implications of UBI in a small open economy in contrast to the benchmark experiment with capital market clearing. The effective wage rate rises notably in order to clear the labor market following the initial decline in aggregate labor due to UBI. This results in higher returns from joining the formal sector, which in turn leads to a marked increase in the share of the formal sector. The combination of increased consumption due to higher labor earnings and a larger formal sector share results in a substantial rise in consumption tax revenue at the existing pre-UBI rate. Consequently, there is no need to hike the consumption tax rate to finance the UBI.

1.1 Related Literature

This paper is related to the macro-development literature that examines the impacts of economy-wide policies. For instance, Buera, Kaboski, and Shin 2021 looks into the aggregate and distributional impact of microfinance, while Fujimoto, Lagakos, and VanVuren 2023 evaluates the aggregate and distributional effects of publicly funded secondary schooling in developing countries. For a recent survey on the topic, refer to Buera, Kaboski, and Townsend 2023. Similar to these studies, my paper employs a quantitative macroeconomic framework to evaluate a large-scale policy.

My research also contributes to the expanding body of literature exploring the potential effects of UBI. Studies assessing the implications of UBI in developed countries include Daruich and Fernández 2020, Conesa, B. Li, and Q. Li 2023, Guner, Kaygusuz, and Ventura 2021, and Luduvice 2021. My research parallels theirs, as we all use models that incorporate an OLG structure with idiosyncratic labor income shocks with outcomes determined in general equilibrium. However, notable differences are present, especially in the areas of taxation structure, demographic composition, and inter-generational connections.

In the development literature, several papers, such as Gentilini et al. 2019 and Banerjee, Niehaus, and Suri 2019, investigate the potential impact of UBI by drawing insights from prior cash transfers. My paper complements this research by not only investigating the short-term effects but also the long-term implications, considering both tax disincentives and price changes. A study closely aligned with mine is Peruffo, Cavalcanti Ferreira, and Cordeiro Valério 2021. They examine the macroeconomic consequences of UBI for developing economies and juxtapose it with another prevalent anti-poverty strategy: Conditional Cash Transfers. Their research uses a framework similar to mine and sheds light on many of the trade-offs I discuss. They also observe a decline in output and an increase in inequality in the long run, conclusions that align with my findings. However, there are clear differences. My paper focuses on the role of the large informal sector in developing countries, and consequently on its interaction with tax revenue and UBI.

Finally, my paper also contributes to the extensive economic literature that studies informality and its consequences. For an excellent review of this literature, see Ulyssea 2020. In particular, my paper focuses on workers' choices related to human capital investments and their subsequent decision to join the formal or informal sector, as well as how formality is influenced in the new policy environment.

The paper is organized as follows: Section 2 introduces the model. Section 3 explains its calibration, while Section 4 delves into the benchmark experiment. Section 5 discusses the role of capital markets. Finally, Section 6 concludes.

2 Model

The model is set up in continuous time and consists of individuals of varying ages. At every moment, a finite mass of agents is born, starting their life cycle at age 5. They progress through different stages of life and from the age of 58 onwards, they start dying with some probability $\lambda_{age}dt$. Moreover, there is no population growth within the economy.

Lifecycle: During the initial phase of their lives, individuals primarily focus on investing in human capital. Once this phase is completed, they make decisions regarding whether to enter the formal or informal sector labor market. Upon entering the labor market, they decide the number of hours they wish to work. Finally, they retire and gradually exit the economy.

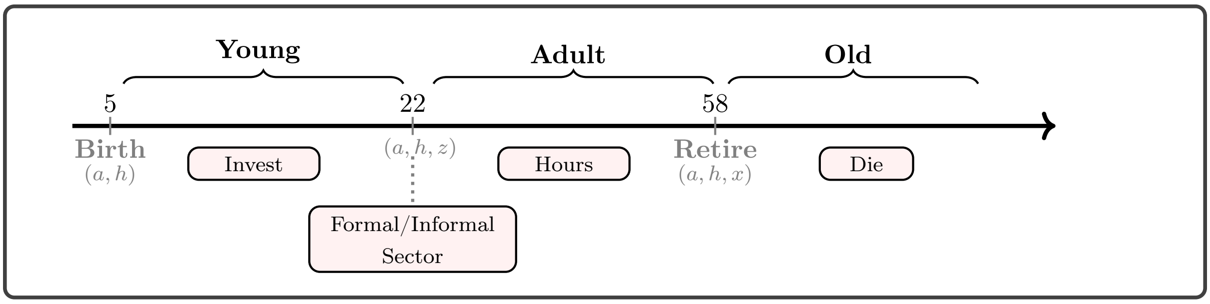


Figure 1: Life Cycle of Agents

Production Side: There is a representative firm with production technology:

$$Y = AK^{\alpha}L^{1-\alpha}$$

where A is TFP, K is aggregate physical capital and L is the aggregate labor in the economy. Aggregate labor is the total sum of efficiency units per unit of time worked, multiplied by the hours of labor supplied by the agents in the economy. Firms are perfectly competitive and thus make zero profits and pay rental rates and unit wages equal to the marginal products:

$$r + \delta_k = \frac{\alpha Y}{K} \quad w = \frac{(1-\alpha)Y}{L}$$

where δ_k is the rate of capital depreciation.

Market Structure: I assume that financial markets are incomplete, i.e., there is no insurance available against labor productivity shocks or mortality shocks later in life. Additionally, I impose a credit limit, restricting the use of credit for self-insurance. Agents in the economy can only self-insure against these risks by accumulating a risk-free bond that yields a real interest rate of r. In equilibrium, the total net supply of this bond equals the capital stock K in the economy.

2.1 Agent's Maximization Problem

Young Phase:

$$V_0(a, h) \equiv \max_{c_t, i_t} \int_5^{22} e^{-\rho(t-5)}u(c_t)dt + e^{-\rho 17} \max \left\{ \mathbb{E}_z V_{22}^f(a, h, z), \mathbb{E}_z V_{22}^{in}(a, h, z) \right\}$$

$$
\begin{aligned}
da_t &= \left[y_t^l + ra_t - c_t - i_t - T(y_t^l, c_t, a_t)\right]dt \\
dh_t &= [((1-n_t)h_t)^{\gamma_1} i_t^{\gamma_2} - \delta_h h_t]dt \\
a_t &\geq 0 \\
y_t^l &= A_y w h_t n_t
\end{aligned}
$$

Agents begin their lives with assets and human capital. They make decisions regarding their consumption and investments in human capital. I employ the standard Ben-Porath (1967) formulation for the production of human capital. Human capital can be accumulated by allocating less time to the labor market (low n_t) and investing resources (i_t). In addition to expenditures on consumption, agents must also consider taxes and transfers, denoted as $T(y_t^l, c_t, a_t)$.

At the end of this stage, they make the decision to enter the formal or informal sector. I next describe these sectors and the adult phase in detail.

Adult Phase

I first explain the features common to both sectors before delving into the differences.

During this phase of their lives, agents decide, in addition to consumption, how many hours of labor to supply. Supplying labor increases labor income but incurs disutility from labor. They begin receiving labor productivity shocks following a two-state Poisson process. Furthermore, human capital evolves exogenously, which can be thought of as returns to experience. It's important to note that at this stage, human capital does not depend on the amount of labor supplied in the labor market.

The formal sector differs from the informal sector in the following ways: i) Labor Productivity, ii) Return on assets , and iii) Tax and Transfers.

Formal Sector :

$$
\begin{aligned}
V_{22}^f(a,h,z) \equiv \max_{c_t, n_t} \mathbb{E}_{22} \int_{22}^{58} e^{-\rho(t-22)} u(c_t, n_t) dt &+ e^{-\rho 36} V_{58}(a) \\
da_t &= \left[y_t^l + r^f a_t - c_t - T^f(y_t^l, c_t, a_t)\right]dt \\
dh_t &= \big(\eta_0 - 2\eta_1 t\big) h_t dt \\
z_t &\in \{z_l, z_h\} \\
a_t &\geq 0 \\
n_t &\in [0,1] \\
y_t^l &= A_h^f w h_t n_t z_t
\end{aligned}
$$

Informal Sector :

$$
\begin{aligned}
V_{22}^{in}(a,h,z) \equiv \max_{c_t, n_t} \mathbb{E}_{22} \int_{22}^{58} e^{-\rho(t-22)} u(c_t, n_t) dt &+ e^{-\rho 36} V_{58}(a) \\
da_t &= \left[y_t^l + r^{in} a_t - c_t - T^{in}(y_t^l, c_t, a_t)\right]dt
\end{aligned}
$$

$$dh_t = \big(\eta_0 - 2\eta_1 t\big)h_t dt$$
$$z_t \in \{z_l, z_h\}$$
$$a_t \geq 0$$
$$n_t \in [0,1]$$
$$y_t^l = A_h^{in} w h_t n_t z_t$$

It's well-documented that labor productivity is higher in the formal sector, as reflected in the formal-informal wage gap. There is an extensive literature that has studied this across a wide range of countries. See Ulyssea 2020 for recent survey.

Return on assets can vary between the formal and informal sectors, and this difference can be due to varying levels of financial inclusion. For instance, individuals with lower income often have limited access to savings products and encounter barriers when trying to access formal financial institutions, as discussed in detail by Karlan, Ratan, and Zinman 2014. In contrast, formal sector workers typically have access to a wider range of saving options with higher interest-earning potential, such as the stock market, pension funds, and mutual funds.

The informal sector activities are typically hidden from the government, making it difficult to tax labor or asset income in this sector. Moreover, in most developing countries, virtually all poor are part of the informal sector. Consequently, most assistance programs are directed toward this sector. Therefore, I assume different tax and transfer rules for these sectors.[2]

Old Phase

The agents retire at the age of 58. At this stage, they live off their asset income and make decisions regarding consumption, taking into account taxes and transfers. They also begin to experience mortality shocks and ultimately exit the economy. Formally, they solve:

$$V_{58}(a) \equiv \max_{c_t} \mathbb{E}_{58} \int_{58}^{D} e^{-\rho(t-58)} u(c_t) dt$$
$$da_t = \big[r a_t - c_t - T(0, c_t, a_t)\big] dt$$
$$a_t \geq 0$$
$$D = \min\{t : x_t = dead\}$$

Tax, Transfers and Formal Sector Entry Cost:

To evaluate the UBI policy, it's important to understand how it will alter the current tax and transfer system. I use the Indian economy for calibration, with a primary focus on consumption and labor taxes.

India's transfer system is complex, involving contributions from both central and state governments and encompassing thousands of programs targeting various individuals. However, I primarily focus on the two major programs that account for the highest spending and have also been extensively studied in the literature.

[2]More on this in the calibration section.

The most substantial subsidies directed towards assisting low-income individuals are the food subsidies and fertilizer subsidies. These subsidies combined amounted to 1.63% of GDP in the fiscal year 2011-12. Additionally, the NREGS program offers wages conditional on work. The benefits in the benchmark economy are targeted to the informal sector only. This is a reasonable approximation since these programs specifically target individuals within the informal sector, and by their design, exclude formal sector workers.

Now, I describe how the taxes and transfers are incorporated in the model.

The tax function varies depending on the stage. Specifically, for the young and old stages, I use the following tax function:

$$T(y_t^l, c_t, a_t) \equiv \tau_c c - ubi$$

The young and old individuals are subject to consumption taxes only, and they do not receive any benefits in the benchmark economy. The introduction of UBI in the model will be implemented by adjusting the value of *ubi* within the tax function.

The tax function used for formal and informal sectors are given by:

$$T^f(y_t^l, c_t, a_t) \equiv \max\{\tau_l(y^l - \bar{y}_l), 0\} + \tau_c c_t - ubi$$

$$T^{in}(y_t^l, c_t, a_t) \equiv (\tau_c - \tau_{subsidy}) c_t - ubi$$

Workers in the formal sector are subject to labor income taxes, which are represented by a simple linear form. Additionally, workers from both sectors are subject to taxes on consumption. However, workers in the informal sector receive subsidies, $\tau_{subsidy}$.

To account for the conditional work program, NREGS, the budget constraint of informal sector workers changes depending on whether they choose to work for NREGS. If they decide to work for NREGS, it is given as follows:

$$da_t = \left[w_g n_t + r^{in} a_t - c_t - T^{in}(y_t^l, c_t, a_t)\right] dt$$

Here, w_g represents the wage associated with the NREGS program.

Several factors, beyond just tax evasion, influence an individual's decision to join the informal sector. In developing countries, other reasons for joining the informal sector include the under-supply of formal jobs, high search costs associated with finding formal employment, the lack of networks for transitioning from the informal to the formal sector, and the greater flexibility of informal jobs compared to formal jobs. However, these aspects are not considered explicitly in this model. To account for such forces in a parsimonious way, I introduce a flat tax in the formal sector, fee, which is incorporated into the budget constraint. Formally, the budget constraint of formal sector is modified as follows:

$$da_t = \left[y_t^l + r^f a_t - c_t - T^f(y_t^l, c_t, a_t) - fee\right] dt$$

Stationary Equilibrium

The model includes agents with ages $\in [5, \infty)$ at any given time. I study stationary equilibrium which is an equilibrium in which none of the policy functions, prices, or distribution functions vary with the calendar date.

Let $\boldsymbol{s_j}$ be the age-specific state vector of an individual of age $j \in [0, \infty)$. Mathematically, a stationary recursive competitive equilibrium is a collection of decision rules i) $\{c_j(\boldsymbol{s_j})(\boldsymbol{s_j}), n_j(\boldsymbol{s_j})(\boldsymbol{s_j}), i_j(\boldsymbol{s_j}), I_{formal}(\boldsymbol{s_{22}})\}$; ii) value functions $\{V_j(\boldsymbol{s_j})\}$; iii) aggregate capital and labor $\{K, L\}$; iv) prices $\{r, w\}$; v) tax policy $\{\tau_l, \tau_c, \tau_{subsidy}, w_{ng}, ubi, G\}$ and vi) density $g_j(\boldsymbol{s_j})$ such that[3]:

1. Given prices and tax policy, $\{V_j(\boldsymbol{s_j})\}$ satisfies the HJB equation and $\{c(\boldsymbol{s_j}), n(\boldsymbol{s_j}), i(\boldsymbol{s_j}), I_{formal}(\boldsymbol{s_{22}})\}$ are the associated decision rules.
2. Given prices, aggregate capital and labor inputs solve the representative firm's problem, i.e., it equates marginal products to prices.
3. Markets clear:

$$K = \int_{j \notin [22,58)} \int a_j dG_j(\boldsymbol{s_j}) + \int_{j \in [22,58)} \int_{I_{formal}=1} A_a^f a_j dG_j(\boldsymbol{s_j}) + \int_{j \in [22,58)} \int_{I_{formal}=0} A_a^{in} a_j dG_j(\boldsymbol{s_j}), \quad \left(A_a^f \equiv \frac{r^f}{r}, A_a^{in} \equiv \frac{r^{in}}{r}\right)$$

$$L = \int_{j \in [0,22]} \int A_y n_j(\boldsymbol{s_j}) dG_j(\boldsymbol{s_j}) + \int_{j \in [22,58)} \int_{I_{formal}=1} A_h^f h_j n_j(\boldsymbol{s_j}) z_j dG_j(\boldsymbol{s_j}) + \int_{j \in [22,58)} \int_{I_{formal}=0} A_h^{in} h_j n_j(\boldsymbol{s_j}) z_j dG_j(\boldsymbol{s_j})$$

$$Y - \delta_k K = \int_j \int c_j(\boldsymbol{s_j}) dG_j(\boldsymbol{s_j}) + \int_{j \in [0,22]} \int i_j(\boldsymbol{s_j}) dG_j(\boldsymbol{s_j}) + G + \int_{j \in [22,58)} \int_{I_{formal}=1} fee \quad dG_j(\boldsymbol{s_j})$$

4. Government budget holds with equality:

$$G_{outside} + \int_{j \in [22,58)} \int_{I_{formal}=0} (w_g n_j(\boldsymbol{s_j}) + \tau_{subsidy} c_j(\boldsymbol{s_j})) dG_j(\boldsymbol{s_j}) = \int_j \int \tau_c c_j(\boldsymbol{s_j}) dG_j(\boldsymbol{s_j}) + \int_{j \in [22,58)} \int_{I_{formal}=1} \max\{\tau_l(y_j^l(\boldsymbol{s_j}) - \bar{y}_l), 0\} dG_j(\boldsymbol{s_j}) + \lambda_x \int_{j \in [58,\infty)} \int a_j dG_j(\boldsymbol{s_j})$$

   $G_{outside}$ is government expenditure which is assumed to be exogenous.

5. Finally, the density evolves according to the Kolmogorov Forward Equation (KFE).

[3] More details about HJB and KFE are discussed in the appendix.

3 Calibration

I use India as the benchmark economy. In India, informal sector employment is estimated to be over 70%. To calibrate my model, I rely on two main sources of data: I use two primary data sources: (i) India Human Development Survey (IHDS) 2004-05, 2011-12; Education Survey 2014, NSS 71st Round. I also use data from various government ministries in India to gather information on macroeconomic aggregates.

One model period is normalized to 10 years. The parameters can be grouped into: those that can be estimated independently of the model or are based on estimates provided by other studies, and those that I choose so that the model-generated data match a given set of targets. I next explain calibration in detail.

Aggregate production function: All prices are in 2012 Indian rupees (INR). These are normalized, using the TFP parameter A, such that the average annual income of a formal sector agent at age 54 is INR 195,581 in the data – is equal to one in the model.

The capital share α is set to 0.33. I calibrate the depreciation rate of capital, $\delta_k = 0.31$, so that the benchmark stationary equilibrium annual real interest rate, $r = 1\%$. This amounts to yearly depreciation of 3.1%.

Preferences: Households have instantaneous utility that is separable over consumption and hours worked:

$$u(c,l) = \frac{c^{1-\sigma}}{1-\sigma} - \kappa \frac{l^{1+\nu}}{1+\nu}$$

I set risk aversion parameter, σ, to 1.5. The Frisch elasticity parameter, ν is set to 3. These values are in the range of what's commonly used in the literature. The weight on the labor supply component of utility, κ, is set so that average hours worked are equal to 0.33 in stationary equilibrium. Discount rate, ρ, is set to 0.41, which amounts to yearly discounting of 0.96.

Table 1: Externally Chosen Parameters

Description	Parameter	Value	Source
Discount rate	ρ	0.41	Standard Value
Risk Aversion	σ	1.5	Standard value
Frisch elasticity	$1/\nu$	0.33	Standard value
Human Capital Depreciation Rate	δ_h	0.44	Dinerstein et.al 2022
Capital Share	α	0.33	Standard value
Labor Tax Rate	τ_l	0.15	Indian Tax Schedule
Labor Tax Break	$\bar{y}_l$	9.2	Indian Tax Schedule
Death Rate	λ_x	See Appendix	WHO Life Tables

Notes: See the text for more details.

Human Capital production function: I set δ_h to 0.44 (yearly 4.3%) following Dinerstein, Megalokonomou, and Yannelis 2022. γ_1 is time coefficient and γ_2 is investment coefficient. I target average years of schooling of among agents aged 22 years and average investment expenditure respectively to discipline these parameters.

Other parameters: Young agents' productivity parameter, A_y, is set such that average young agents income matches the average income of individuals aged 22 and below. Formal sector fee, fee, is set such that the model matches the formal sector share in 2012. Mortality rate, λ_x, is calibrated using mortality data provided in WHO Life Tables[4].

Taxes and Transfer: There are two types of taxes: a labor income tax and a consumption tax. I chose labor tax parameters $\tau_l, \bar{y}_l$ to 0.15 and 9.2, respectively. This is in line with the 2012 India tax schedule. Additionally, the consumption tax rate, τ_c, is chosen in equilibrium to balance the government budget.

I select the value of $\tau_{subsidy}$ to ensure that the expenditure on subsidies represents 1.63% of GDP. Similarly, I set w_{ng} to align with government spending on NREGS at 0.33% of GDP in 2012.

The consumption tax rate $\tau_c$is set to ensure the government budget remains balanced, and $G_{outside}$ is set so that $\frac{G_{outside}}{Y}$ is 11.08%, as observed in 2011-12.

Table 2: Internally Calibrated Parameters

Description	Parameter	Moment	Value	Data	Model
TFP	A	Avg Formal Income (Age 54)	10.25	1	1
Young TFP	A_y	Avg Young Income	0.2	0.073	0.07
Time Coefficient	γ_1	Avg Schooling	0.74	7.96	8.9
Investment Coefficient	γ_2	Avg Expenditure	0.11	0.038	0.035
Capital Depreciation Rate	δ_k	Interest Rate	0.31	1%	1%
Labor Disutility	κ	Avg Labor Hours	113	0.33	0.33
Formal Sector Fee	fee	Formal Sector Share	2.32	9.3%	9.5%
Consumption Subsidy	$\tau_{subsidy}$	Subsidy Expenditure	0.06	1.63%	1.63%
NREGS wage	w_{ng}	NREGS Expenditure	1.24	0.33%	0.33%
Consumption Tax	τ_c	Govt Consumption	0.18	11.08%	11.08%

Notes: See the text for more details.

Income: I estimate the wage process and the returns to experience using panel data from the IHDS spanning the years 2004-05 and 2011-12. The age component of productivity does not depend on the sector and the initial human capital. I run the following Mincer style regression on the sample of individuals aged 22-58 in year 2004:

$$ln(w_{i,t}) = \beta_0 + \beta_1 formal_i + \beta_2 age_{i,t} + \beta_3 age_{i,t}^2 + \beta_4 education_i + \gamma_t + \epsilon_{i,t}$$

where w_i is total income divided by the total number of hours worked. The η_0, η_1 are set to β_2, β_3 respectively. Recall that wages also have sector-specific (formal or informal) productivities. I obtain them directly from data using the estimated Mincer equation.

[4]See Appendix for values.

First, I normalize formal labor productivity parameter, A_h^f, to 1. I then back out informal labor productivity parameter, A_h^{in}.[5]

It's challenging to learn about income shocks from the IHDS panel data, as I observe individuals for just 2 periods. Moreover, in continuous-time models, the frequency at which shocks arrive is a property of the stochastic process. Ideally, this would require data at a much higher frequency to accurately estimate the shock process. This is in contrast to discrete-time models, where the frequency of earnings shocks is determined by the assumed time period. My strategy to overcome this challenge is to infer high frequency earnings dynamics from the high-order moments of annual earnings changes. This approach follows Kaplan, Moll, and Violante 2018. The idea is that more platykurtic distribution i.e., the distribution with more mass in the shoulders is likely to be generated from a process that is dominated by small frequent shocks and leptokurtic distribution is likely to have been generated by an earnings process that is dominated by large infrequent shocks. I model the earnings $(y_{i,t})$ process as:

$$dln(y_{i,t}) = \eta_0 t - \eta_1 t^2 + de_{i,t}$$
$$de_{i,t} = -\Delta_e dq_{i,t}^1 + \Delta_e dq_{i,t}^2, \quad \Delta_e \equiv e_h - e_l$$
$$e_i \equiv log(z_i) \quad i \in \{l, h\}$$

The Poisson process $q_{1,t}$ counts the frequency with which an agent moves from a high to a low efficiency level, while the Poisson process $q_{2,t}$ counts how often it moves from a low to a high level. An individual cannot move to a particular efficiency level while being in that same level, the arrival rates of both stochastic processes are state dependent. In particular, you move from state low to high with intensity λ_{lh}. You move from state high to low with intensity λ_{hl}.

Recall, once you enter the labor market, labor earnings in the model change because of productivity shocks, age gradient, and labor supply decisions. The previously estimated productivity shock will overstate inequality in the model because higher productivity will result in increased labor supply, while lower productivity will lead to decreased labor supply. To address this, I adjust the productivity grid to ensure that the earning patterns in the model closely resemble what I see in the actual data.

Given that the IHDS data report annual earnings, I use the process described above to simulate earnings at a high frequency, aggregate them to annual earnings, and minimize the distance between the process and the data moments. Table 3 displays the values obtained through this procedure. The shocks intensity is relatively high. This is attributed to the fact that earnings changes appear to be generated by a platykurtic distribution, which means there is more concentration of data in the shoulders of the distribution.

In Figure 2, you can observe the income earning moments generated by the model after estimating the shock process and adjusting the shock grid. The fitted earnings process closely aligns with the moments. However, as is typical in models of this class, matching wealth inequality at the top end is challenging, which results in more income discrepancies in that part of the distribution.

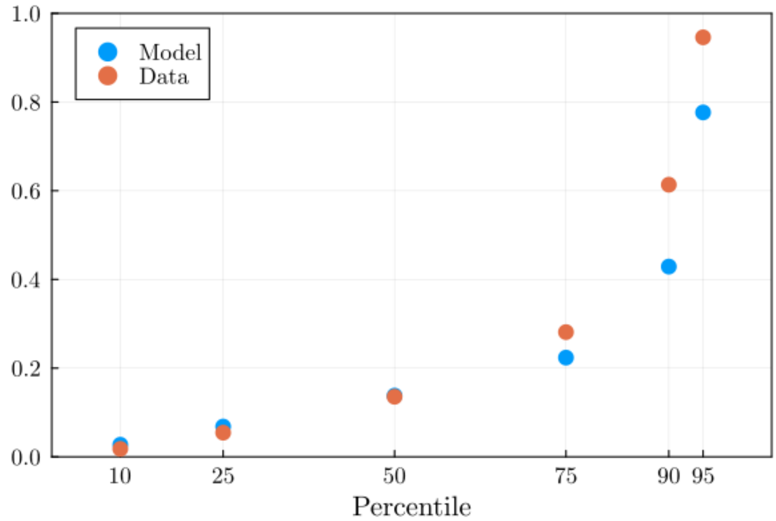
[5] See Appendix for more details.

Table 3: Estimates of Earning Process

Description	Parameter	Value
Returns to Experience	η_0, η_1	0.0331,0.0003
Shocks	z_l, z_h	0.52, 1.33
Shock Intensity	$\lambda_{lh}, \lambda_{hl}$	22.62, 29.96
Formal & Informal Labor Productivity	A_h^f, A_h^{in}	1,0.57
Formal & Informal Asset Returns (Annual)	r^f, r^{in}	0.01,0

Notes: The shocks are adjusted as described in the text. The shock intensities are expressed as decadal rates.

Figure 2: **Income Moments Comparison**



Notes: y-axis is expressed as a fraction of formal-sector average income at age 54, which is normalized to 1. This figure shows a comparison of income between the data and the model in stationary equilibrium.

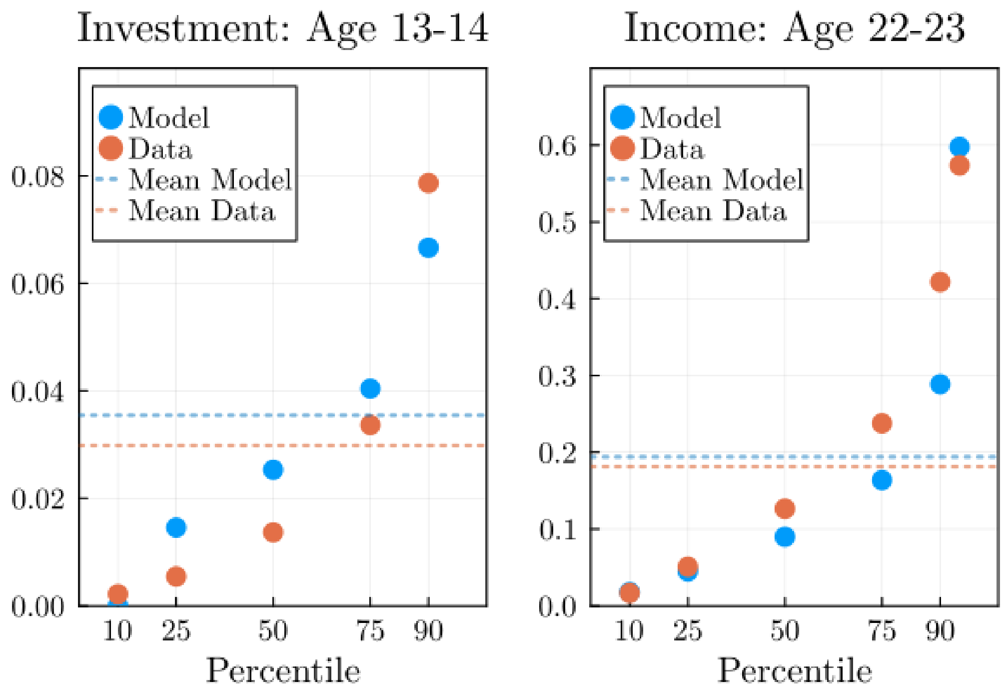
As mentioned earlier, the return on assets can vary between sectors. For the benchmark scenario, I set the annual informal sector interest rate, r^{in}, to 0 and formal sector interest rate, $r^f = r = 1\%$.

Initial Distribution: For the benchmark economy, I assume that everyone starts with the same level of human capital but different levels of assets. I choose the initial distribution of agents as a log-normal distribution with parameters μ_a and σ_a. The variation in these parameters results in differences in investment expenditure and schooling, as well as in the distribution of human capital at the end of stage 1 in the model. To calibrate these parameters, I select various moments for investment expenditure at age 14 and income moments at age 23. This approach ensures that the initial distribution aligns with both income and investment variations in the data. Following this approach, I set μ_a, σ_a to 0.47 and 1.26. Figure 3 compares the model generated moments to the ones from the data.

3.1 Formal Sector/Informal Sector Elasticity

We lack reliable estimates regarding how individuals shift between formal and informal sectors in India in response to changes in wages within these sectors. To get a reasonable

Figure 3: **Investment and Income Moments**



Notes: y-axis is expressed as a fraction of formal-sector average income at age 54, which is normalized to 1. In the left figure, we can observe a comparison of investment expenditure across the population and the model at different percentiles. The right-hand figure shows a comparison of income between the data and the model at various percentiles. These specific moments were the ones targeted during the calibration.

estimate, I turn to the findings from Abel et al. 2022. They report results from a RCT that provided temporary incentives for individuals to enter the formal sector in Mexico. Mexico is a developing economy and has a large presence of informal sector with more than 50% workers employed in the informal sector.

The RCT focuses on students who intend to enter the labor market upon graduation. The treatment group is incentivized to join the formal sector with a transfer, amounting to 17% of the average monthly salary for a full-time entry-level formal job, and this bonus is disbursed for a duration of 6 months. As a result of this intervention, employment among individuals in the treatment group increase by 16.8% during the first year. This effect persists and remains stable over the second year as well.

Comparing the model directly with RCT poses some challenges. First, in their sample, starting formal sector wages are 9% lower than those in the informal sector. However, over the first year, while informal sector wages remain fairly constant, formal sector wages increase by 35%. In my model, the wages rise at the same rate but the informal sector wages are 0.56 times the formal sector wages. Second, the life cycle profile can differ between Mexico and India and can be different across sectors. However, this might not be a big concern because the returns to experience in Mexico, as noted by Lagakos et al. 2018, peak at 40%, which is quite close to the 38.8% peak in the calibrated life cycle profile for India. Third, the job market conditions differ across countries. These factors suggest that the benefits of joining the formal sector can differ between Mexico and India, and this disparity can impact the elasticity between the formal and informal sectors.

To understand elasticity implied by the model, I replicate the same experiment within the calibrated model. In this replication, I treat the experiment as taking place in partial equilibrium and as entirely unanticipated. Similar to the RCT, I introduce an incentive equivalent to 17% of the average monthly income of formal sector agents aged 23 in the stationary equilibrium of the model. This incentive is offered for 6 months to agents who join the formal sector within the model.

In the data, individuals have the option to join either the formal or informal sector. However, in the model, the choice to enter the formal sector depends on initial assets. If you have assets above a certain threshold, you decide to join the formal sector. To mimic the experiment's conditions, I draw a population from a uniform distribution around the 10% of the asset cutoff. This approach ensures that the group receiving the transfer closely resembles the individuals who are part of the RCT.

Table 4: Comparison with Mexico RCT

	RCT	Model
Change in formal employment (1 yr)	16.8%	4.7%
(95% Confidence Interval)	[3.5%,30.1%]	
Control: Informal Share	0.25	0.37
Change in formal employment (2 yr)	14.5%	-
(95% Confidence Interval)	[3%,26%]	

Notes: In the model, the RCT amount is introduced as an exogenous shock to agents aged 22 in the initial equilibrium. Their subsequent decisions factor in this RCT. The difference between the new share and the share in the initial equilibrium is reported above. By design, the model's control group share should be 0.5. However, in computations, its value depends on the coarseness of the asset grid and generally differs from 0.5.

From Table 4, it is evident that the model-implied elasticity falls within the range suggested by the data. However, it is towards the lower end of the confidence interval. This outcome is expected, given that in the model, there is a one-time entry into the formal sector, which differs from the data. We anticipate a higher elasticity in an environment where transitions occur frequently without long-term commitments.

4 Results

There have been numerous discussions regarding the appropriate level of UBI to provide. While it's generally agreed that UBI should at least meet the poverty line in a given country, achieving this in a developing country like India poses significant challenges.

To put it in perspective, the international poverty line used by the World Bank in 2011 PPP terms was $1.9. For India, providing this amount as UBI would have required 15.3% of the GDP in 2011-12, while the government's tax revenue during that period was only 13.6% of GDP. Consequently, experts and commentators have proposed various alternatives, ranging from UBI set at 0.75 times the poverty line to as low as 0.2 times the poverty line. Some economists have even suggested more targeted approaches, such as providing UBI only to adults.

For the benchmark exercise, I replace the current welfare programs with an UBI of 0.5 times the international poverty line, which amounts to 7.65% of the initial GDP per capita. I'll first explain the implications of funding a UBI with labor taxes before discussing its funding through consumption taxes.

4.1 Financing with Labor Taxes

Recall that I use $\max\{\tau_l(y^l - \bar{y}_l), 0\}$ as the labor tax function. To raise taxes, the government can increase τ_l, decrease $\bar{y}_l$, or employ a combination of both. I demonstrate that labor taxes alone will not suffice to cover the expenses by comparing the initial stationary equilibrium with the final stationary equilibrium after implementing increased taxes. This holds true whether the government attempts to raise τ_l or reduce $\bar{y}_l$.

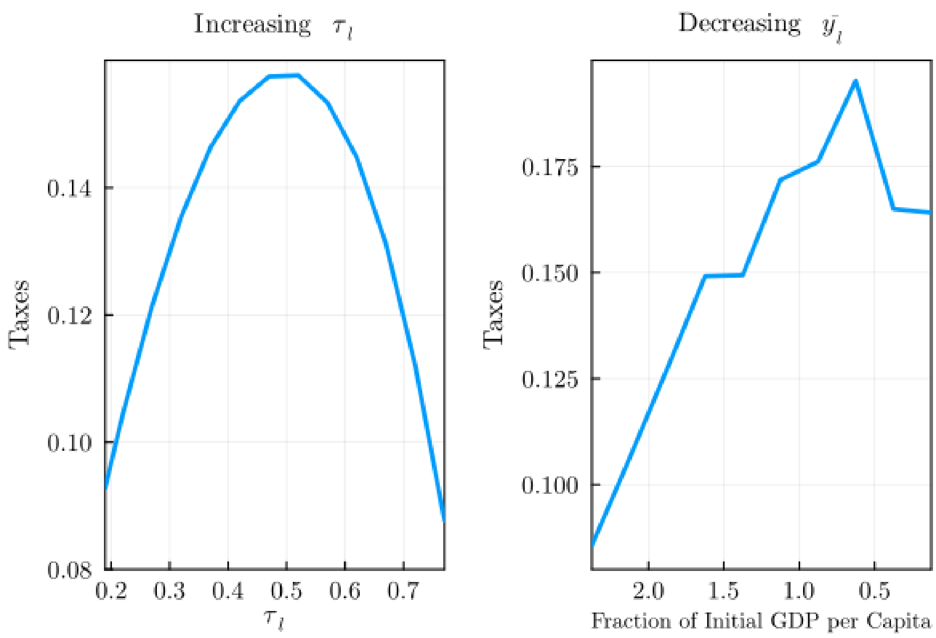
To finance UBI, an allocation of 7.65% of the initial GDP is required. Considering that the NREGS and subsidies will be replaced by the UBI, approximately 2% of the initial GDP becomes available. However, the remaining amount needed for the UBI must be sourced from labor taxes. I conduct two experiments to demonstrate that labor taxes alone are insufficient to fund the UBI. In the first experiment, I increase the labor tax rate, τ_l, to assess its impact on the new stationary equilibrium. In the second experiment, I reduce the tax exemption threshold, $\bar{y}_l$, resulting in more agents being subject to taxation and, consequently, generating additional revenue.

As illustrated in Figure 4, both methods of financing UBI are inadequate. In the left panel of the figure, as the labor tax rate, τ_l, increases, there is a corresponding rise in the amount of taxes collected, thus reducing the difference with the required collection. It reaches its peak at around $\tau_l = 0.5$ before gradually declining. However, even at its peak, the collected amount is considerably below the necessary tax collection. A similar trend is observed when attempting to lower exemption threshold, as depicted in the right panel.

In order to understand these results, notice that when you increase the tax rate or reduce exemption threshold, agents have three margins of adjustment to alter their labor taxes. First, agents might reduce their human capital. Second, they may decrease their labor supply. Lastly, they could choose to exit the formal sector entirely to avoid labor taxes altogether.

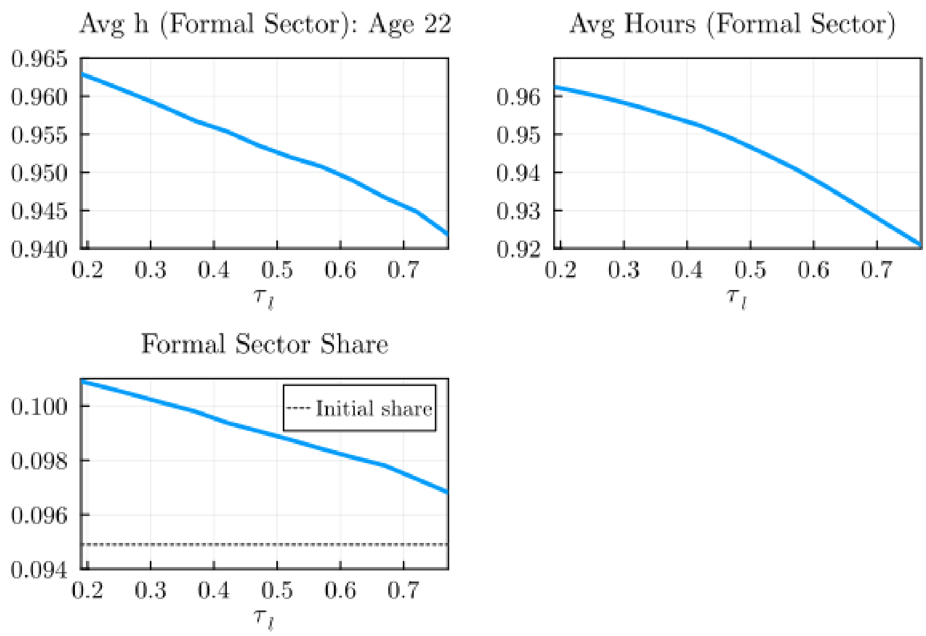
For a given $\bar{y}_l$, an increase in τ_l imposes a larger tax burden for labor incomes exceeding this threshold. All else equal, agents with incomes above this threshold tend to reduce their labor hours. Over time, as agents adjust their human capital downwards, there's a corresponding decrease in labor hours, as illustrated in Figure 5. There's minimal adjustment in the decision to join the formal sector. This is primarily because many agents can still secure exemptions by reducing their labor hours or human capital. This occurs because the exemption threshold in the initial equilibrium is set at an already high value, 2.5 times the GDP per capita.

Figure 4: **Labor Taxes and Revenue**



Notes: Both the figures are associated with the final stationary equilibrium, given the new labor tax parameters. The y-axis values are normalized as a fraction of taxes needed in order to fund UBI. The 'tax needed' refers to the amount required to fund UBI at the prices from the initial equilibrium, taking into account the retraction of the initial programs.

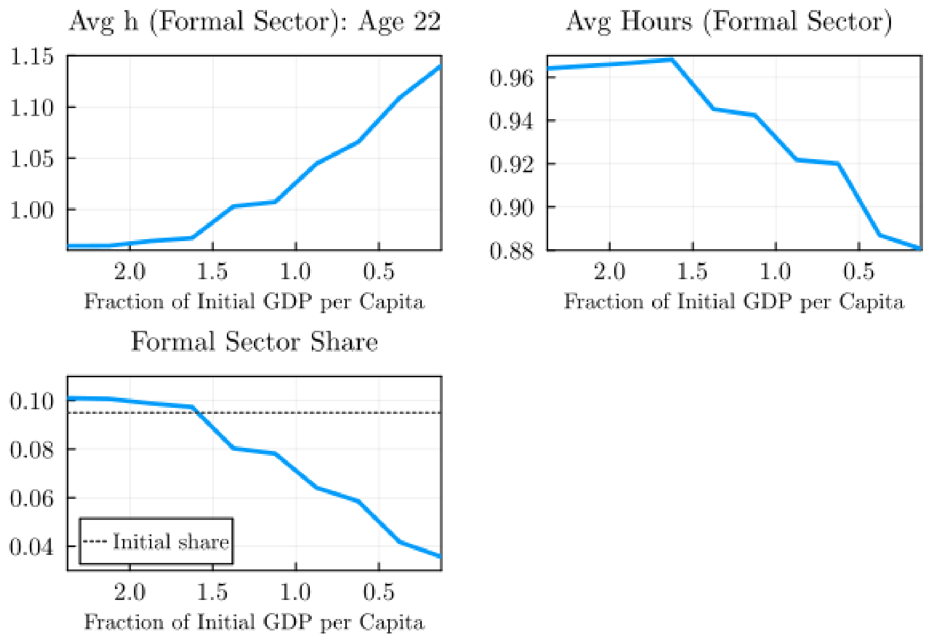
Figure 5: **Increasing** τ_l



Notes: All the figures are associated with the final stationary equilibrium given the new labor tax rate, τ_l. For the first 2 figures, the y-axis values are normalized by the corresponding values in the initial stationary equilibrium.

Figure 6 illustrates the effects of decreasing $\bar{y}_l$ on human capital accumulation, labor supply, and the share of the formal sector. For a given labor tax rate, τ_l, as the exemption threshold decreases, more agents become liable to pay taxes. This decreases the benefit of joining the formal sector. Thus, in the long run, the most significant adjustments are observed on this margin, as shown in the bottom left subfigure. As more agents leave the formal sector, average human capital rises, given that it's predominantly the wealthiest individuals—those with the highest human capital—who remain. Conversely, average working hours diminish, as those with greater human capital work fewer hours in the model.

Figure 6: **Decreasing $\bar{y}_l$**



Notes: All the figures are associated with the final stationary equilibrium, given the new tax exemption threshold, $\bar{y}_l$. For the first 2 figures, the y-axis values are normalized by the corresponding values in the initial stationary equilibrium.

4.2 Financing with Consumption Taxes

In this section, I discuss the long-run aggregate and distributional consequences of financing UBI through consumption taxes.

As previously mentioned, the existing welfare system is replaced by UBI. To maintain budget neutrality, an increase in the consumption tax rate becomes necessary. The required net increase to ensure this neutrality is 6.6 and 12.7 percentage points for the formal and informal sectors, respectively. This translates to a new consumption tax rate, τ_c =0.25. Given this new environment, I compute the stationary equilibrium and report the results below.

Table 5 presents the effects of this policy on both aggregate outcomes and measures of inequality. The output falls by -9.4%. Almost 52% of that fall is driven by fall in aggregate capital and the rest explained by aggregate labor. As UBI provides an income floor, it decreases precautionary savings leading to fall in the aggregate capital in the economy. This subsequently results in a significant increase in the interest rate and a corresponding decrease in the efficiency wage rate. However, even as output decreases, aggregate consumption rises by 2.5%, driven by a reduction in savings and increased consumption by poorer agents.

Table 5: Benchmark Experiment

Aggregates Response		
Variable	**Changes (%)**	
Output	-9.4	
Capital	-14.6	
Labor	-6.6	
Consumption	2.5	
r(p.p)	0.28	
Avg Human Capital (Age 22)	-2.9	
Avg Hours	-9.2	
Formal Sector (p.p)	0.85	
Consumption Tax Revenue	60.9	
Labor Tax Revenue	-15.6	
Distributional Changes		
Variable	**Initial Eqm**	**Final Eqm**
Income Gini	0.39	0.42
Income Gini (Post-Tax)	0.38	0.4
Wealth Gini	0.52	0.65
Top 10 Wealth Share	0.43	0.52
Top 20 Wealth Share	0.67	0.77

Notes: All changes are expressed as percentage deviations from the initial stationary equilibrium, unless stated otherwise. Wealth-related statistics reported above are for those aged 22 and above, while income-related statistics pertain to agents aged 22-58.

To understand how UBI and increased taxes impact human capital accumulation and labor hours, I conduct two experiments as shown in Table 6. Both experiments use the market clearing prices in the initial equilibrium. The first experiment keeps the distribution of state variables for agents aged 22 as it was in the initial equilibrium. The objective of this experiment is to observe how the labor hours of adults respond in the presence of UBI and increased taxes. We observe a decline of 9.4%, primarily attributed to the income effect. In the second experiment, human capital is allowed to adjust. We see a decline in human capital accumulation. This decline can be attributed to credit-constrained young agents choosing to consume more rather than investing in human capital. Additionally, agents increase their labor hours slightly more than before. In the benchmark case, when price effects are considered, both average human capital and labor hours show minor adjustments compared to the results of experiment 2.

The discussion on the formal and informal sector shares is deferred to the next section. Furthermore, labor tax revenue decreases due to agents accumulating less human capital and reducing their labor supply. As the financing relies on consumption taxes, these naturally rise.

Table 6: Effect of UBI and Taxes on Human Capital and Labor Hours

Variable	**Experiment 1**	**Experiment 2**	**Benchmark**
Avg Human Capital (Age 22)	0	-3.6	-2.9
Avg Hours	-9.4	-8.9	-9.2

Notes: All aggregates are presented as percentage changes from the initial equilibrium. Prices are held constant at levels observed in the initial equilibrium. In Experiment 1, the distribution of agents at age 22 remains as in the initial equilibrium, but taxes are modified and UBI is introduced for adult agents. Experiment 2, on the other hand, permits adjustments in human capital.

Turning to distributional changes, both wealth and income inequality worsen compared to the baseline. A rise in income inequality can result from change in asset income or labor income. Labor income can be affected by changes in either human capital or labor supply. I argue below that the changes are primarily due to change in labor response of formal vs informal sector workers.

To understand why labor hours are a significant driver of income inequality, I set the labor supply to match that of the initial equilibrium. I then use this fixed labor supply in the benchmark experiment detailed in this section. This scenario is referred to as the fixed labor supply equilibrium in Table 7 below.

As illustrated in Table 7, using the fixed labor supply results in a slight decrease in inequality, underscoring the significant influence of labor supply. In the final equilibrium, the labor supply in the formal sector diminishes to a lesser extent (-3%) compared to the informal sector (-10%), which contributes to the increase in income inequality. The post-income tax Gini also rises, due in part to increased income inequality and the fact that informal agents end up paying higher consumption taxes than they did previously.

Table 7: Effect of Labor Hours on Income Inequality

Variable	**Initial Eqm**	**Fixed Labor Supply**	**Final Eqm**
Income Gini	0.392	0.385	0.416

Notes: Initial Eqm refers to the economy before the introduction of UBI, while Final Eqm pertains to the economy post-UBI implementation. ‘Fixed labor supply’ indicates conditions in the post-UBI economy, but with the labor supply maintained at the level observed in the initial equilibrium.

Finally, due to the rise in income inequality and the decline in precautionary savings by poorer agents, there’s an increase in the wealth share of top percentile agents. This, in turn, boosts the wealth Gini coefficient, that’s further exacerbated by the increased interest rate.

4.3 Impact of UBI and Consumption Taxes on the Formal Sector Share

In this section, I conduct experiments to examine the interactions between UBI, consumption taxes, and the share of the formal sector. All experiments are carried out in a partial equilibrium setting to exclude any impact from price changes.

Role of Increase in Consumption Taxes: As consumption taxes increase and NREGS is eliminated to fund UBI, the benefits of the informal sector decrease substantially compared to the initial equilibrium. All else equal, more agents join the formal sector on the margin. To illustrate this, first row of Table 8 presents the results with UBI set to 0 and human capital maintained at its initial equilibrium level. We see that the formal share increases by 1.72 p.p (18.1%) compared to the initial stationary equilibrium.

Role of UBI: All else equal, we expect that the unconditional income from UBI should increase both leisure and consumption for the working age individuals of both sectors in the model. In order to understand how it impacts the share of the formal sector, we need to focus on the choices of the agent who was indifferent between joining either sector in the initial equilibrium. In particular, if the this agent is still indifferent, it suggests the sectoral shares will remain unchanged. However, if he chooses to join the informal sector, we anticipate a rise in the informal sector share.

Notice, that hourly wage rate is lower in the informal sector. This implies that leisure is cheaper. Hence, one can buy more leisure and consumption by being in the informal sector as compared to the formal sector. Therefore, the marginal agents shift to the informal sector in the presence of UBI[6]. This observation is evident from second row of Table 8. The formal share drops to 0.72 p.p, down from its initial increase of 1.72 p.p.

Table 8: Formal Sector Share Change (p.p)

Experiments			Formal Share
Avg h: Age 22 (%)	**Cons Tax (p.p): Formal, Informal**	**UBI**	
0	6.6, 12.7	0	1.72
0	6.6, 12.7	0.5×Poverty Line	0.71
0.5	6.6, 12.7	0	2.4
-3.6	6.6, 12.7	0.5×Poverty Line	0.34

Notes: The changes mentioned above are presented in percentage points and are relative to the initial stationary equilibrium. In this equilibrium, the formal sector had an initial share of 0.095, with consumption tax rates for the formal and informal sectors being 0.18 and 0.12, respectively. Refer to the main text for additional details.

It's noteworthy to see the response of human capital accumulation when it's allowed to adjust. With no UBI but increased taxes for the informal sector, there's a positive adjustment in human capital. As evidenced in third row of Table 8, more individuals ultimately opt for the formal sector. However, upon introducing UBI, the accumulation of human capital decreases by 3.6%. The increase in the formal share also declines notably. The agents in the economy shift more resources towards consumption in their younger years in the presence of UBI, consequently decreasing overall productivity in the economy.

4.4 Welfare Analysis

This section discusses the welfare implications of the benchmark experiment. To do so, I use the wealth equivalent variation (WEV) following Conesa, Costa, et al. 2018 and Herkenhoff and Raveendranathan 2020. WEV is the one-time wealth transfer that agents would require in the initial equilibrium to make them weakly better off in the economy

[6] This is easiest to see in a simple one period model. Refer to appendix for that.

with UBI. It is my preferred welfare measure because it allows for aggregation with a clear interpretation and recognizes that consumers re-optimize their decisions following the one-time transfer. Next, I define it formally.

Let s_j^{-a} represent all the age j specific state variables, excluding assets a. We can define WEV as

$$\min WEV$$

$$s.t \qquad V_j^{old}(s_j^{-a}, a + WEV) \geq V_j^{new}(s_j^{-a}, a)$$

$$a + WEV \geq 0$$

Here, V_j^{old} denotes the value function for an age j agent in the initial equilibrium, while V_j^{new} pertains to the value function for an age j agent in final equilibrium. Notice that value functions do not depend on the calendar date t. This is because I am only comparing the stationary equilibria without taking into account the transition to the new stationary equilibrium in the presence of UBI. We can also compute the average welfare effect of the reform for a cohort of age j by integrating WEV across all agents within that cohort.

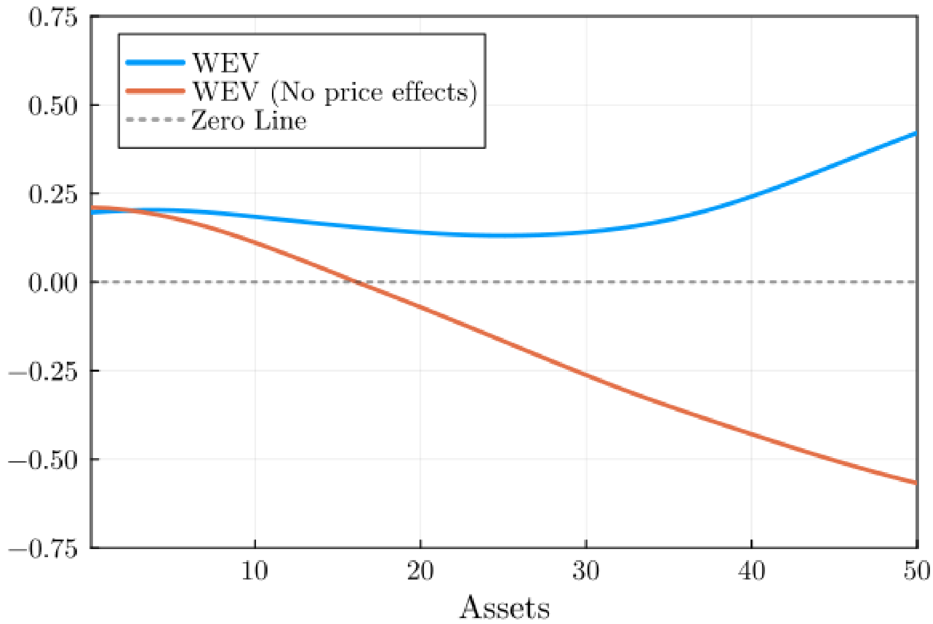
$$Avg_{wev}^{j} = \int WEV(s_j^{-a}, a) dG_j(s_j^{-a}, a)$$

Under the veil of ignorance, I find that unborn agents would favor the economy with UBI. They would require a transfer equivalent to 20% of the average assets held by agents of age 5 in the initial equilibrium. Interestingly, all agents, whether rich or poor, would benefit under the UBI scheme. To understand this result, we need to examine the pros and cons of UBI within the model. For poorer agents, they stand to gain significantly as they can smooth out their consumption in the face of shocks and credit constraints. This benefit is less pronounced for richer agents. Conversely, increased consumption taxes take away a portion of one's income, and this effect is stronger for richer agents. So, all else being equal, we would expect poor agents to favor UBI and the rich to oppose it, especially if the taxes are too high. This trend is evident in the red line from Figure 7. However, the key reason richer agents show a preference for UBI comes from price effects, as indicated by the blue line in the figure. In particular, interest rates are higher in the UBI economy. This means the richer agents can consume more than before, offsetting the drawbacks of increased consumption taxes.

5 Small Open Economy and UBI

Previous sections discuss the long-term implications of UBI with labor and consumption taxes. Recall that in the benchmark exercise, savings decline significantly, leading to a substantial increase in the interest rate. In this section, I explore the implications of UBI in a small open economy. The capital markets are exogenous and individual saving decisions do not impact the equilibrium interest rate. The aggregate capital is exogenously maintained at the pre-UBI level. Agents are allowed to save at the initial equilibrium interest rate, while the wages adjust to clear the labor market. Upon introducing the UBI, the consumption tax rate is adjusted to ensure budget neutrality. The aim is to understand the role of capital markets in driving some of the observed results.

Figure 7: **Welfare Effects**



Notes: The y-axis represents WEV as a percentage of average initial assets. The blue line represents the WEV for the benchmark experiment. In contrast, the red line calculates the WEV by comparing the initial stationary equilibrium to one where the prices are the same as in the initial equilibrium, but with the UBI and increased taxes as specified in the UBI benchmark case.

From Table 9, it's evident that some of the results vary substantially. Specifically, wages surge by a 41.2% to clear the labor market. This increase enhances the benefits of joining the formal sector, resulting in a 8.8 p.p boost in the formal sector share. Moreover, there's no need to raise the consumption tax rate. This is because consumption and, consequently, consumption tax revenues increase due to higher labor earnings and a larger formal sector share. The labor tax revenue sees a significant percentage increase, largely because it starts from a very low base. Nevertheless, this increase also aids in funding UBI. As for other aggregates, the substantially higher wages in the presence of UBI lead to a greater decrease in human capital than before. Changes in average hours remain in line with previous findings.

6 Conclusion

This paper studies the feasibility of financing UBI and its consequent effects in the context of developing countries with a large informal sector. Specifically, I look at the feasibility of labor income and consumption taxes to fund a UBI amount equivalent to half the international poverty line. I build a general equilibrium life cycle model where agents are subject to credit constraints and wage fluctuations. Importantly, I incorporate the choice of joining the formal or informal sector. The model is able to incorporate most of the benefits and costs associated with UBI. Finally, for quantitative experiments, the model is calibrated using Indian data.

In the benchmark experiment, I replace all the welfare programs and provide a UBI equal to half the international poverty line. I find that funding UBI solely through labor

Table 9: Role of Capital Market

Aggregates Response		
Variable	**Benchmark Changes (%)**	**Exogenous Capital Market**
w	-3.2	41.2
Avg Human Capital (Age 22)	-2.9	-4.2
Avg Hours	-9.2	-9.1
Formal Sector (p.p)	0.85	8.8
Cons Tax Revenue	60.9	58.5
Cons Tax rate	6.6,12.7	0,6
Labor Tax Revenue	-15.6	155.3

Notes: All changes are expressed as percentage deviations from the initial stationary equilibrium, unless stated otherwise.

income taxes is not feasible. When these taxes are raised, agents react by decreasing their human capital, reducing labor hours, and shifting away from the formal sector. Though it's feasible to fund UBI by consumption taxes, it needs a substantial rise in the consumption tax rate. Moreover, in the long run, there are negative effects on output, capital, human capital accumulation, and labor hours. Furthermore, both the income inequality and wealth inequality increase in the long run.

One important contribution of this paper is highlighting the contrasting effects of increased consumption taxes and UBI on the formal sector's share. On one hand, removing subsidies and raising consumption taxes pushes people out of the informal sector. On the other hand, UBI encourages more agents to gravitate towards the informal sector where leisure is more affordable. Additionally, I emphasize how results differ for a small open economy. When the interest rate is exogenous, wages rise significantly. There's no need to increase the consumption tax rate because higher labor earnings and a greater formal share generate sufficient consumption tax revenue to fund UBI.

My paper underscores the importance of understanding the long-run implications of large-scale policies. The gains observed in the short run can either amplify or, in some cases, turn negative when we consider the long-run perspective, especially considering the relevant distortions and feedback effects. Simultaneously, we can utilize studies assessing short-term impacts to validate model implications, thereby enhancing credibility of macro models for policy analysis.

References

Abel, Martin et al. (2022). "Can temporary wage incentives increase formal employment? Experimental evidence from Mexico". In: Publisher: IZA Discussion Paper.

Achdou, Yves et al. (2022). "Income and wealth distribution in macroeconomics: A continuous-time approach". In: *The review of economic studies* 89.1. Publisher: Oxford University Press, pp. 45–86.

Aiyagari, S. Rao (1994). "Uninsured idiosyncratic risk and aggregate saving". In: *The Quarterly Journal of Economics* 109.3. Publisher: MIT Press, pp. 659–684.

Bachas, Pierre, Lucie Gadenne, and Anders Jensen (2020). *Informality, consumption taxes and redistribution.* Tech. rep. National Bureau of Economic Research.
Banerjee, Abhijit, Rema Hanna, et al. (2022). “Social protection in the developing world”. In: *Mimeo.*
Banerjee, Abhijit, Paul Niehaus, and Tavneet Suri (2019). “Universal basic income in the developing world”. In: *Annual Review of Economics* 11. Publisher: Annual Reviews, pp. 959–983.
Ben-Porath, Yoram (1967). “The production of human capital and the life cycle of earnings”. In: *Journal of political economy* 75.4, Part 1. Publisher: The University of Chicago Press, pp. 352–365.
Buera, Francisco J., Joseph P. Kaboski, and Yongseok Shin (2021). “The macroeconomics of microfinance”. In: *The Review of Economic Studies* 88.1. Publisher: Oxford University Press, pp. 126–161.
Buera, Francisco J., Joseph P. Kaboski, and Robert M. Townsend (2023). “From micro to macro development”. In: *Journal of Economic Literature* 61.2. Publisher: American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203-2425, pp. 471–503.
Conesa, Juan Carlos, Daniela Costa, et al. (2018). “Macroeconomic effects of Medicare”. In: *The Journal of the Economics of Ageing* 11, pp. 27–40.
Conesa, Juan Carlos, Bo Li, and Qian Li (2023). “A quantitative evaluation of universal basic income”. In: *Journal of Public Economics* 223. Publisher: Elsevier, p. 104881.
Daruich, Diego and Raquel Fernández (2020). *Universal basic income: A dynamic assessment.* Tech. rep. National Bureau of Economic Research.
Dinerstein, Michael, Rigissa Megalokonomou, and Constantine Yannelis (2022). “Human capital depreciation and returns to experience”. In: *American Economic Review* 112.11. Publisher: American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203, pp. 3725–3762.
Fujimoto, Junichi, David Lagakos, and Mitchell VanVuren (2023). *Aggregate and Distributional Effects of ‘Free’Secondary Schooling in the Developing World.* Tech. rep. National Bureau of Economic Research.
Gentilini, Ugo et al. (2019). *Exploring universal basic income: A guide to navigating concepts, evidence, and practices.* World Bank Publications.
Ghatak, Maitreesh and François Maniquet (2019). “Universal basic income: some theoretical aspects”. In: *Annual Review of Economics* 11. Publisher: Annual Reviews, pp. 895–928.
Guner, Nezih, Remzi Kaygusuz, and Gustavo Ventura (2021). “Rethinking the welfare state”. In: Publisher: CEPR Discussion Paper No. DP16275.
Hanna, Rema and Benjamin A. Olken (2018). “Universal basic incomes versus targeted transfers: Anti-poverty programs in developing countries”. In: *Journal of Economic Perspectives* 32.4. Publisher: American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203-2418, pp. 201–226.
Herkenhoff, Kyle F and Gajendran Raveendranathan (2020). *Who bears the welfare costs of monopoly? The case of the credit card industry.* Tech. rep. National Bureau of Economic Research.
Jensen, Anders (2022). “Employment structure and the rise of the modern tax system”. In: *American Economic Review* 112.1. Publisher: American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203, pp. 213–234.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante (2018). “Monetary policy according to HANK”. In: *American Economic Review* 108.3. Publisher: American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203, pp. 697–743.

Karlan, Dean, Aishwarya Lakshmi Ratan, and Jonathan Zinman (2014). “Savings by and for the Poor: A Research Review and Agenda”. In: *Review of Income and Wealth* 60.1. Publisher: Wiley Online Library, pp. 36–78.

Krueger, Dirk and Alexander Ludwig (2016). “On the optimal provision of social insurance: Progressive taxation versus education subsidies in general equilibrium”. In: *Journal of Monetary Economics* 77. Publisher: Elsevier, pp. 72–98.

Lagakos, David et al. (2018). “Life cycle wage growth across countries”. In: *Journal of Political Economy* 126.2. Publisher: University of Chicago Press Chicago, IL, pp. 797–849.

Luduvice, André Victor D. (2021). *The macroeconomic effects of universal basic income programs*. Tech. rep.

Peruffo, Marcel, Pedro Cavalcanti Ferreira, and André Cordeiro Valério (June 2021). *Universal Basic Income in Developing Countries: Pitfalls and Alternatives*. en. SSRN Scholarly Paper. Rochester, NY.

Phelan, Thomas and Keyvan Eslami (2022). “Applications of markov chain approximation methods to optimal control problems in economics”. In: *Journal of Economic Dynamics and Control* 143. Publisher: Elsevier, p. 104437.

Ulyssea, Gabriel (2020). “Informality: Causes and consequences for development”. In: *Annual Review of Economics* 12. Publisher: Annual Reviews, pp. 525–546.

Yang, Fan Frank (n.d.). “From Means-Tested Programs to Universal Basic Income-The Role of Endogenous Participation in Transfer Programs”. In: ().

7 Appendix

7.1 Stationary Equilibrium

This section expands on the definition of stationary equilibrium presented in the Section 2 of the paper. I first outline the HJB equations for the agent and then detail the Kolmogorov Forward equation, which is essential for describing the distribution of agents across the relevant state variables.

HJB equations

I detail the HJB equations in a backward manner. All the equations presented below pertain to a stationary equilibrium, with t denoting age. Given that the mortality rate remains constant[7] after age 85. Consequently, we obtain a stationary HJB equation for ages beyond 85 as outlined below:

$$(\rho + \lambda_{85})V(a) = \max_c u(c) + V_a(a)\big[ra - c - T(0, c, a)\big]$$

For age $\in [58, 85)$, we have

$$(\rho + \lambda_t)V(a, t) = \max_c u(c) + V_a(a, t)\big[ra - c - T(0, c, a)\big] + V_t$$

Now, I describe the HJB equations for the adult agents (age $\in [22, 58)$) in the model. It's important to note that, post age 22, human capital can be expressed as a function of (h_{22}, t). This relationship is integrated into the equations presented below.

Formal Sector :

$$\begin{aligned}
\rho V^f(a, z_i, h_{22}, t) = \max_{c,n} u(c, n) + V_a^f(a, z_i, h_{22}, t)\big[y^l + r^f a - c - T^f(y^l, c, a)\big] + \\
\lambda_{i,j}\big(V^f(a, z_j, h_{22}, t) - V^f(a, z_i, h_{22}, t)\big) + V_t \\
y^l = A_h^f w h_t n z_i \\
h_t = h_{22} e^{\left(\eta_0 t - \eta_1 t^2\right)}
\end{aligned}$$

Informal Sector :

$$\begin{aligned}
\rho V^{in}(a, z_i, h_{22}, t) = \max_{c,n} u(c, n) + V_a^{in}(a, z_i, h_{22}, t)\big[y^l + r_a^{in} - c - T^{in}(y^l, c, a)\big] + \\
\lambda_{i,j}\big(V^{in}(a, z_j, h_{22}, t) - V^{in}(a, z_i, h_{22}, t)\big) + V_t \\
y^l = A_h^{in} w h_t n z_i \\
h_t = h_{22} e^{\left(\eta_0 t - \eta_1 t^2\right)}
\end{aligned}$$

Finally, for the young agents, we have

[7] Refer to the calibration section in the appendix for details.

$$\rho V(a,h,t) = \max_{c,i,n} u(c) + V_a(a,h,t)\big[y^l + ra - c - i - T(y^l, c, a)\big] +$$
$$V_h(a,h,t)[((1-n)h)^{\gamma_1} i^{\gamma_2} - \delta_h h] + V_t$$
$$y^l = A_y w h n$$

Kolmogorov Forward Equations (KFE)

I describe the KFE starting age 5 and proceed forward.

Young:

$$\partial_t g(a,h,t) = -\partial_a (s(a,h,t)g - \partial_h(\mu_h(a,h,t)g$$
$$g(a,h,5) = g_5(a,h) \qquad \text{Exogenously Given}$$

Formal Sector:

$$\partial_t g^f(a, z_j, h_{22}, t) = -\partial_a (s^f(a, z_j, h_{22}, t) g^f - \lambda_{j,i} g^f(a, z_j, h_{22}, t) + \lambda_{i,j} g^f(a, z_i, h_{22}, t)$$
$$g^f(a, z_i, h, 22) = I_{formal}(a, h, 22^-)\left[\frac{\lambda_{j,i}}{\lambda_{i,j} + \lambda_{j,i}} g(a, h, 22^-)\right]$$

Informal Sector:

$$\partial_t g^{in}(a, z_j, h_{22}, t) = -\partial_a (s^{in}(a, z_j, h_{22}, t) g^{in} - \lambda_{j,i} g^{in}(a, z_j, t) + \lambda_{i,j} g^{in}(a, z_i, h_{22}, t)$$
$$g^{in}(a, z_i, h_{22}, 22) = (1 - I_{formal}(a, h, 22^-))\left[\frac{\lambda_{j,i}}{\lambda_{i,j} + \lambda_{j,i}} g(a, h, 22^-)\right]$$

Old phase:

$$\partial_t g(a,t) = -\lambda_t g(a) - \partial_a (s(a,t)g$$
$$g(a, 58) = \sum_i \int g^f(a, z_i, h_{22}, 58^-) dh + \sum_i \int g^{in}(a, z, h_{22}, 58^-) dh$$

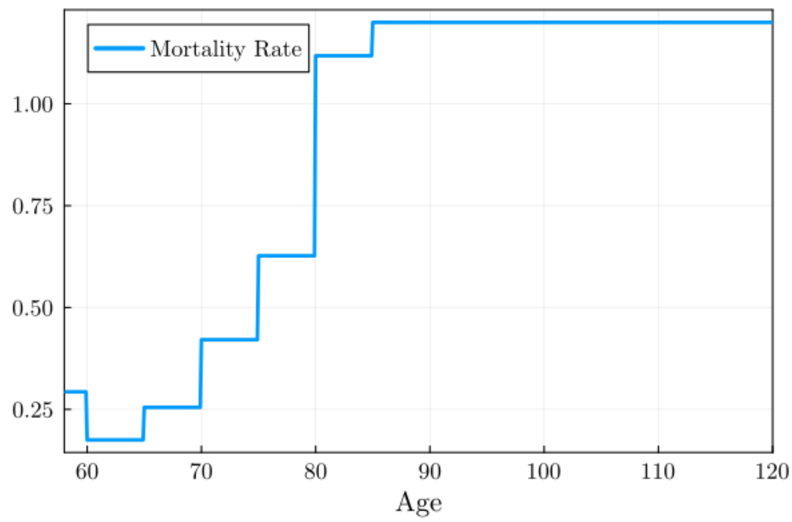
where $s(\ldots)$ represents the optimal saving rules obtained from solving the HJB equations.

7.2 Calibration Details

Mortality Rate (λ_{age})

I use data from the WHO Life tables for the year 2019, which provides death probabilities in five-year age intervals. In my model, I introduce mortality shocks from age 58 onwards. I adjust the mortality rate accordingly.

Figure 8: **Mortality Rate**



Age Profile

Table 10: Age Coefficients

	(1)
Age	0.0331***
	(0.0033)
Age Squared	-0.0003***
	(0.0000)
Formal	0.5686***
	(0.0144)
Constant	1.5080***
	(0.0658)
Obs	92917
Education Controls	Yes
Year FE	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;

As explained in the main text, I estimate the wage process and the returns to experience using panel data from the IHDS spanning the years 2004-05 and 2011-12. I run the following Mincer style regression on the sample of individuals aged 22-58 in year 2004:

$$ln(w_{i,t}) = \beta_0 + \beta_1 formal_i + \beta_2 age_{i,t} + \beta_3 age_{i,t}^2 + \beta_4 education_i + \gamma_t + \epsilon_{i,t}$$

where w_i is total income divided by the total number of hours worked. Table 10 reports the result from above regression.

The η_0, η_1 are set to β_2, β_3 respectively. Recall that wages also have sector-specific (formal or informal) productivities. I obtain them directly from data using the estimated Mincer equation. First, I normalize formal labor productivity parameter, A_h^f, to 1. I then back out informal labor productivity parameter, A_h^{in}, from the regression above as follows:

$$A_h^{in} = \frac{exp(\beta_0)}{exp(\beta_0 + \beta_1)} = 0.566$$

7.3 UBI and Formal Sector Share in Single Period Model

This section elaborates on the intuition presented in Section 4.3. In a single-period model, the agent maximizes:

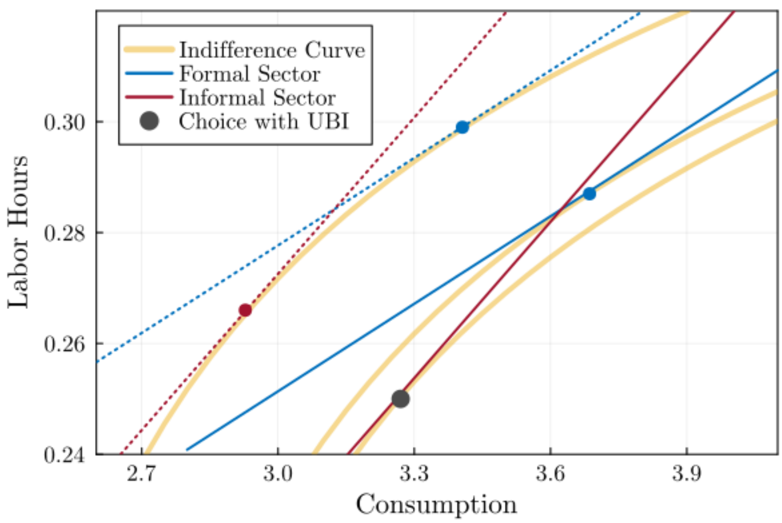
$$\max_{I_f, c, n} \frac{c^{1-\sigma}}{1-\sigma} - \kappa \frac{l^{1+\nu}}{1+\nu}$$

$$c^f = (1-\tau_l) w^f l^f - \tau + ra + ubi \quad \text{(Formal Sector)}$$

$$c^{in} = w^{in} l^{in} + ra + ubi \quad \text{(Informal Sector)}$$

In Figure 7, we analyze the choices of an agent who is indifferent between joining either the formal or informal sector when $ubi = 0$. With the introduction of ubi, the budget constraint in both sector shifts outward. This results in the agent being able to achieve a higher utility in the informal sector, as represented by the black dot in the figure. This preference for the informal sector after the introduction of UBI stems from the fact that the price of leisure is lower there. Consequently, the agent can both consume more and enjoy greater leisure in the informal sector.

Figure 9: **Marginal Agent Choices**



Notes: The above figure illustrates the choices of the marginal agent in a one-period model. The dotted lines represent budget constraints before the introduction of UBI.

7.4 Computation Details

The model includes agents with ages $\in [5, \infty)$ at any given time. In order to solve the model numerically, we need to set an upper age limit. I've chosen an upper limit of 120 years, which agents in the model have an ex ante probability of less than 10^{-3} of reaching. I use markov chain approximation method to solve the model. For details on this method, refer to Phelan and Eslami 2022. Next, I give a brief overview of this method followed by its application in solving the model in this paper.

The value functions must be solved backward, considering the age-specific state variables grid. The broader idea is to approximate the HJB equation as follows:

$$V_t = u\Delta_t + e^{-\rho\Delta_t}\mathbb{P}_t V(t + \Delta_t) \tag{1}$$

where $\mathbb{P}_t$ captures the movement of state variables and have to satisfy the so called local consistency requirement. Once, we have $\mathbb{P}_t$, we can get KFE or density as follows:

$$G'_{t+\Delta_t} = G'_t \mathbb{P}_t \tag{2}$$

To see how to use (1), consider the problem for an agent at age 85. First, we select a grid for assets, a_i, where $i \in 1, 2, \ldots, N$. We then begin with an initial guess for $V_{t+\Delta_t}$ and iterate backward until convergence using the following equation[8].

$$V_t = \Delta_t u_{N\times 1} + e^{\rho\Delta_t}\mathbb{P}_t V_{t+\Delta_t}$$

$$\mathbb{P}_t = \begin{bmatrix} (1-\mathbb{P}^+_{a_1}) & \mathbb{P}^+_{a_1} & 0 & \dots & 0 \\ \mathbb{P}^-_{a_2} & (1-\mathbb{P}^+_{a_2}-\mathbb{P}^-_{a_2}) & \mathbb{P}^+_{a_2} & 0 & \vdots \\ 0 & \mathbb{P}^-_{a_3} & \ddots & \ddots & \vdots \\ \vdots & 0 & \ddots & \ddots & \mathbb{P}^+_{a_{N-1}} \\ 0 & \dots & \dots & \mathbb{P}^-_{a_N} & (1-\mathbb{P}^-_{a_N}) \end{bmatrix}_{N\times N}$$

$$\mathbb{P}^+_{a_i} = \frac{\Delta_t}{\Delta_a}\Big[\max\big\{ra_i - c_i - T(0, c_i, a_i), 0\big\}\Big]$$

$$\mathbb{P}^-_{a_i} = \frac{\Delta_t}{\Delta_a}\Big[\max\big\{-(ra_i - c_i - T(0, c_i, a_i)), 0\big\}\Big]$$

where c_i is chosen optimally, given $V_{t+\Delta_t}$

This probability ($\mathbb{P}$) scheme automatically takes into account the boundary conditions associated with the value function. For example,

$$\mathbb{P}^-_{a_1} = 0 \Rightarrow c_1 \leq ra_1 - T(0, c_1, a_1) \Rightarrow \dot{a}_1 \geq 0$$

This ensure that a remain within feasible bounds. This is similar to the conditions discussed in Achdou et al. 2022.

Once we have $V_{85}(a_i)$, we can proceed backward in a similar fashion to solve the age-specific HJB equation. Additionally, we need to store $\mathbb{P}_t$ in order to obtain densities using (2) .

[8] In practice, I use policy function iteration to converge quickly to the stationary value function.