Australian National University

Crawford School of Public Policy

CAMA

Centre for Applied Macroeconomic Analysis

The Great Indian Savings Puzzle

CAMA Working Paper 60/2024
September 2024

Chetan Ghate
Institute of Economic Growth
Indian Statistical Institute
Centre for Applied Macroeconomic Analysis, ANU

Pawan Gopalakrishnan
Reserve Bank of India

Anuradha Saha
Ashoka University

Abstract

India's savings rate surged from 13% in 1970 to 38% in 2008, declining steadily thereafter to 30% in 2019. Unlike other developing or developed nations, the savings rate in India, and some other countries, shows a hump-shaped trajectory with its peak coinciding with the Great Recession of 2007-2009. We build a neoclassical monetary-growth model to explain the long-run savings pattern in India. We find that the post-2009 decline in inflation is a key factor in explaining the hump shape in the savings rate. The fall in inflation increases future wealth which induces households to increase consumption and lower savings in the future. Consumption smoothing and risk aversion induce households to increase consumption in the initial periods as well. While this smoothes consumption along the transition path, it reduces savings in the initial periods. Thus, household savings are low but rising in the 1990s, peaking along with inflation in 2008 and then declining post-2008. The fit of the model improves considerably when we extend the model to allow for two types of agents: Ricardian and Rule of Thumb. Our model predicts a dynamic association between inflation and household savings that mimics the hump-shaped pattern in savings that India and some other countries have experienced.

Keywords

Indian economic growth, savings rate, non-linear dynamics, monetary-growth models, demographics

JEL Classification

E21, J11, O23, O47

Address for correspondence:

(E) cama.admin@anu.edu.au

ISSN 2206-0332

The Great Indian Savings Puzzle*

Chetan Ghate† **Pawan Gopalakrishnan**‡ **Anuradha Saha**§

September 5, 2024

Abstract

India's savings rate surged from 13% in 1970 to 38% in 2008, declining steadily thereafter to 30% in 2019. Unlike other developing or developed nations, the savings rate in India, and some other countries, shows a hump-shaped trajectory with its peak coinciding with the Great Recession of 2007-2009. We build a neoclassical monetary-growth model to explain the long-run savings pattern in India. We find that the post-2009 decline in inflation is a key factor in explaining the hump shape in the savings rate. The fall in inflation increases future wealth which induces households to increase consumption and lower savings in the future. Consumption smoothing and risk aversion induce households to increase consumption in the initial periods as well. While this smoothes consumption along the transition path, it reduces savings in the initial periods. Thus, household savings are low but rising in the 1990s, peaking along with inflation in 2008 and then declining post-2008. The fit of the model improves considerably when we extend the model to allow for two types of agents: Ricardian and Rule of Thumb. Our model predicts a dynamic association between inflation and household savings that mimics the hump-shaped pattern in savings that India and some other countries have experienced.

Keywords: Indian Economic Growth, Savings Rate, Non-Linear Dynamics, Monetary-Growth Models, Demographics

JEL Code: E21, J11, O23, O47

*The views expressed herein should be attributed to the authors and not to their employers or affiliated institutions.

†Institute of Economic Growth, Delhi and Indian Statistical Institute, Delhi Centre. Email: cghate@iegindia.org, cghate@isid.ac.in

‡Reserve Bank of India, Mumbai. Email: pawangopalakrishnan@rbi.org.in

§Corresponding Author: Ashoka University, Sonipat. Email: anuradha.saha@ashoka.edu.in

1 Introduction

Since the 1970s, there has been a secular rise in the Indian annual gross domestic saving rate, which suddenly reversed in 2008. As shown by the dark blue line in Figure 1, in the mid-1970's India's savings rate was roughly 13 percent of GDP, rising to a peak rate of 38 percent of GDP in 2008.[1] The pre-2008 rise in the savings rate was phenomenal as it even surpassed the savings rates of most advanced economies and BRICS nations - with the exception of China.[2] However, after it peaked there has been a steady decline in the savings rate. Given this non-monotonic trend in the savings rates, this paper asks: What explains the rise and decline in the Indian savings rate? We refer to this as the "Great Indian Savings Puzzle".

The decline in the savings rate is concerning for a variety of reasons. First, its timing in relation to the Great Recession of 2008 suggests a potential connection between the two, emphasizing the need to identify the underlying mechanisms.

Second, the decline in the savings rate from roughly 38 percent of GDP in 2008 to 30 percent of GDP in 2019 (an 8 percentage point decline, or a roughly 21 percentage point decline relative to the peak) also coincides with a similar decline in the relative magnitude of real GDP (RGDP) growth from about 8 percent in 2008 at peak to roughly 6.5 percent average RGDP growth between 2016 to 2019.[3]

Third, in India, there is a strong positive correlation between savings and investments, particularly in terms of gross capital formation or gross fixed capital formation (Figure 2).

[1]Our analysis ends in 2019, before the start of COVID-19. For the sake of consistency, we use data from World Development Indicators (World Bank) for plotting savings rate of the different countries in Figure 1. However, in the rest of the paper, we use the Indian savings data from the Reserve Bank of India (RBI (2023)). For some of the other national accounts data, we refer to the National Accounts Statistics, Government of India (GOI (2023)) There are some differences between the two data sources, but the overall trajectory and magnitudes are close. Furthermore, we work with the gross savings rate instead of the net savings rates because investments with long durability require replacement with lags. Therefore, gross savings provide the source of funds for the replacement of investments due to the depreciation of the capital stock, and for new investments (see Raj (1962)).

[2]While the trends in the savings rate have remained stationary for most countries, both India and China experience non-monotonic trends. Both countries first witnessed a secular rise in savings rates until the mid-2000s. However, post-2008 for India and post-2010 for China, the savings rate in these two economies have remained on a declining trajectory.

[3]RBI reports data for a financial year, which begins in April and ends in March of the consecutive year. In this paper, we have used the first year of the financial year as the year of observation. So 2008 refers to FY 2008-09, although we use both inter-changeably.

Figure 1: Cross Country Patterns of Savings Rate in Select Developed and Developing Nations; Source: WDI.

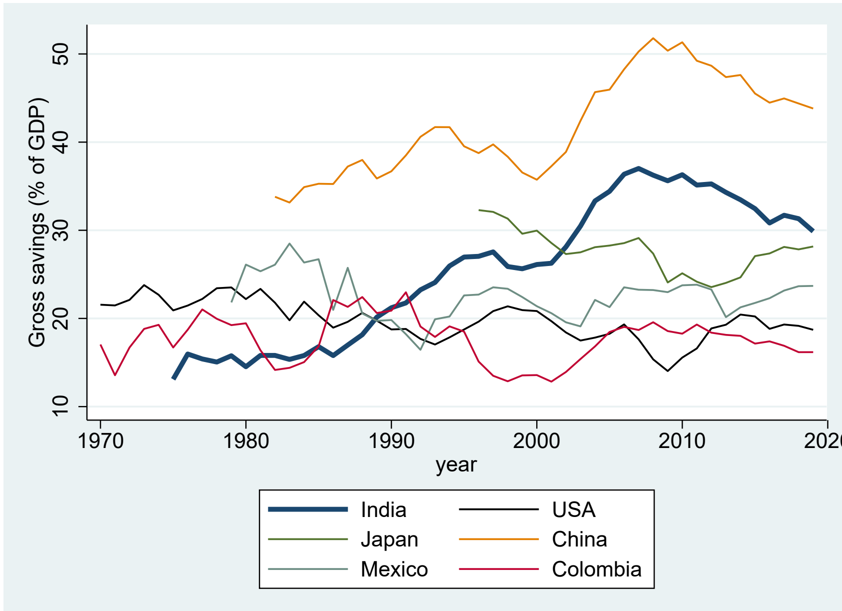
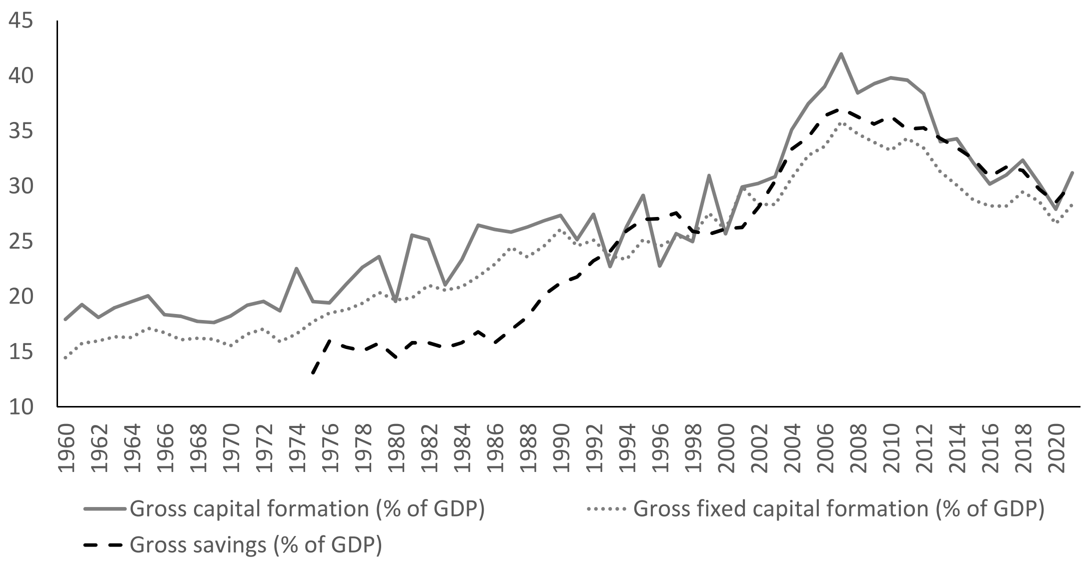


Figure 2: Investment and Savings Rates; Source: National Accounts Statistics, GOI (2023).



Domestic investment activity heavily relies on domestic savings, as indicated by the negligible share of the current account balance in total gross investments since the early 2000s (Figure 3). This highlights the crucial role of domestic savings in driving India's overall growth – and that a prolonged decline in the savings rate may substantially reduce potential growth in India.

Figure 3: The Current Account Balance as a Percentage of Gross Investment in India; Source: National Accounts Statistics, GOI (2023).

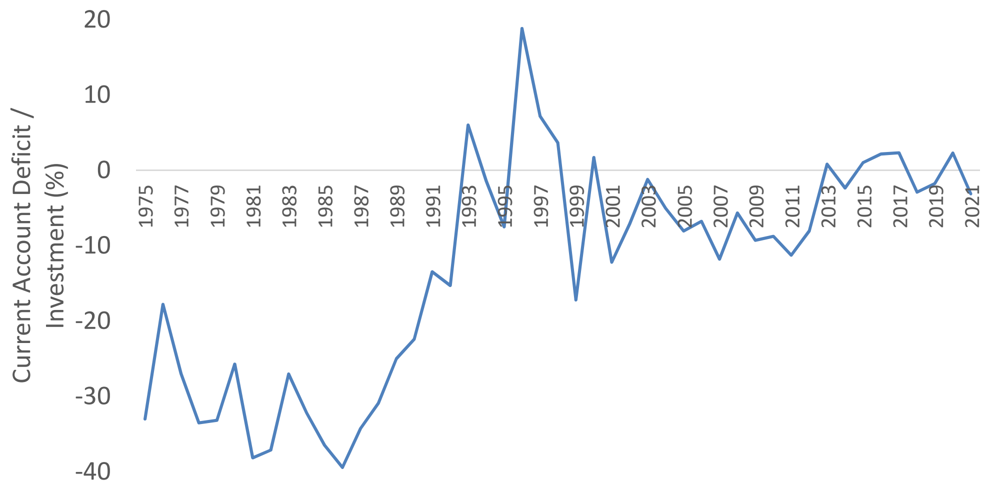
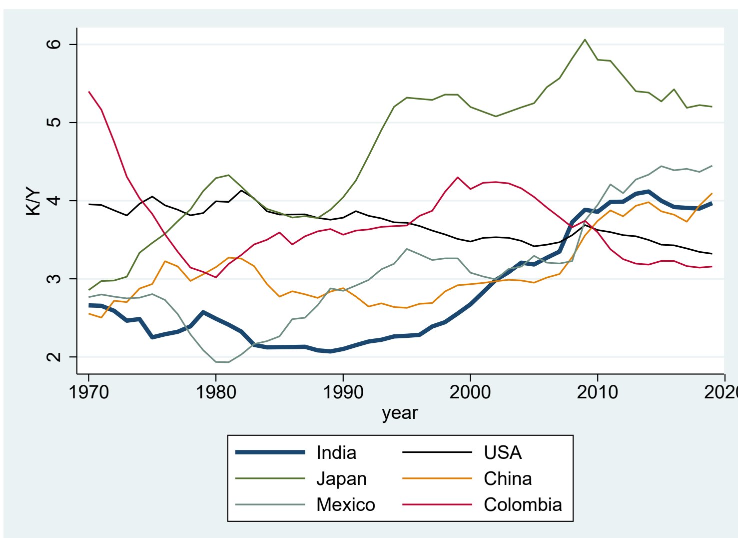


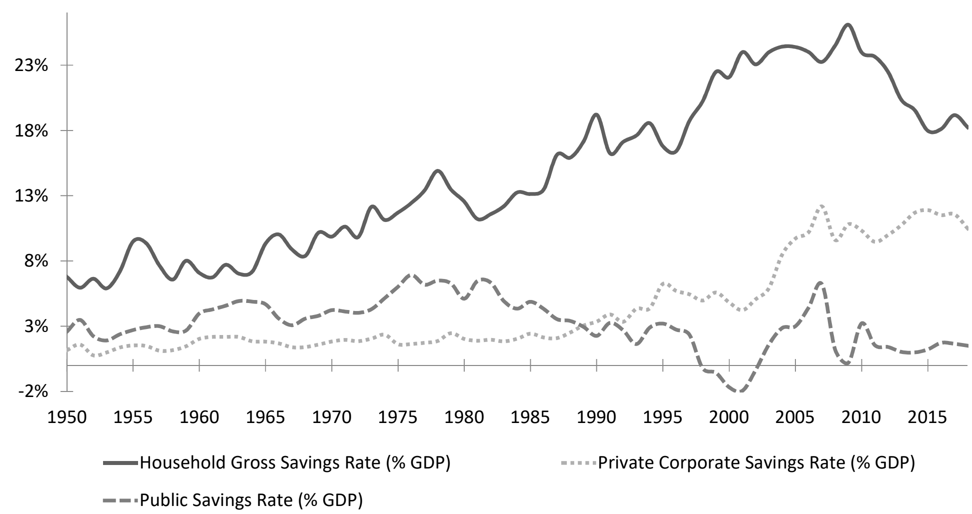
Figure 4: Capital to Output Ratio; Source: Penn World Tables.



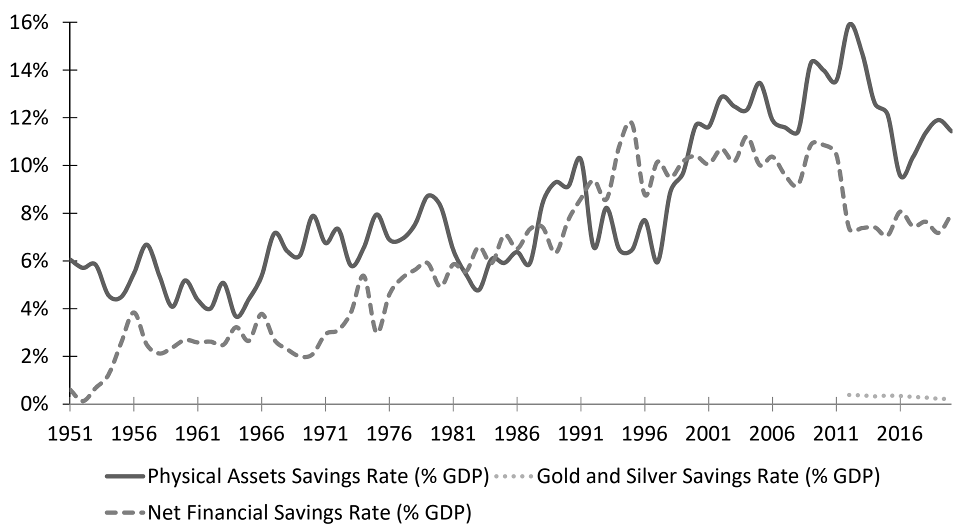
Fourth, the investment rate in India has steadily declined since 2007 (from 41.9% to 30.9% during 2007-2019) which has coincided with the tapering off of the capital-output ratio after 2010 (see Figures 2 and 4). The slowing investment rates could be a source of a growth slowdown in the future.

To further understand the trends in the savings rate, we decompose the savings rate by the different categories (institutions) of savers – firms, households, and government. We find

Figure 5: Savings by Institutions; Source: RBI (2023).



(a) Composition of Gross National Savings



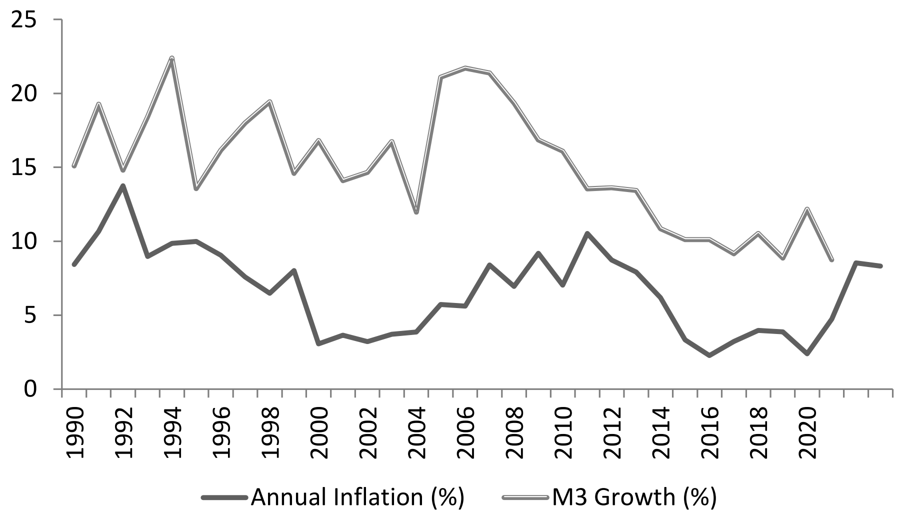
(b) Composition of Household Savings

that the aggregate trend in savings rate is largely driven by household savings. As shown in Figure 5a, on average, households contribute about 62% of aggregate savings from 1950 - 2020.[4] Post-2008, the household savings rate has declined while the private corporate savings rate has stagnated. At a further dis-aggregated level, we find that household savings in both physical

[4]Note that household savings include non-corporate businesses including unregistered micro, small and medium enterprises in addition to individual households.

and financial assets have declined since 2008, with the decline in financial assets preceding that in physical assets (Figure 5b).[5] Given the sizable share of household savings in gross savings, explaining the path of India's savings rate requires us to understand what drives the non-monotonicity in household savings.

Figure 6: M3 Growth and Inflation (GDP deflator); Source: RBI (2023)



To understand the long-term secular trend in the gross Indian savings rate, we build a closed-economy neoclassical monetary growth model where households are the only source of savings in the economy. We show that there is a dynamic association between household savings and the inflation rate that mimics the hump-shape trajectory seen in the Indian data. What drives inflation in the model? As in Cooley and Hansen (1989), we assume that changes in the money supply influence inflation via a cash in advance constraint.[6] Figure 6 shows that the M3 growth rate and the annual inflation rate are strongly correlated.[7] Introducing money via

[5]Broadly, physical assets include equipment, machinery, structures, and ornaments. They also include other intangibles such as intellectual property.

[6]The trend in inflation in India after 2000 can be broken down into three phases. In the first phase, which was from 2000-08, inflation was low, averaging at 4.9%, but rising. The second phase lasted between 2009-13 when inflation was high, averaging at 8.7%, and driven by exogenous shocks to oil and food prices coupled with a revival in domestic demand after the Great Financial Crisis of 2007-2009. The third phase began in 2014 with a decline in inflation and anchored inflation expectations due to the adoption of inflation targeting (see Benes et al. (2017)). During this phase, i.e., 2014-2019, the average inflation was 3.8%. Our model broadly captures these trends as we will show later.

[7]The correlation is 0.43 which is significant at the 5% level of significance. Further, in the period 1991-2019, we reject the claim that M3 growth does not Granger cause inflation at the 10% level of significance. We recognize that fluctuations in uncertainty can play a large role in driving savings behavior. While our model assumes perfect foresight, real money holdings can be seen as a proxy for such uncertainties.

a cash in advance constraint allows us to generate a large deviation from neutrality that helps drive the *hump* in the Indian savings rate.

We proceed in stages. We first use a standard neoclassical growth model as in Fernández et al. (2019), who study savings dynamics for select Latin American economies. When we calibrate their model to India, we find that its predictions are at odds with the Indian data (and other countries with non-monotonic savings trajectories). When we extend Fernández et al. (2019) to allow for risk aversion (a non-unitary inter-temporal elasticity of substitution), we show that this also does not give us the hump in the savings rate that is observed in the data. Our main observation from this exercise is that the analysis in Fernández et al. (2019) is better suited for economies with stationary long-run savings rates that are on their balanced growth paths.

Next, we augment the model to allow for inflation-savings dynamics via a cash-in-advance constraint on consumption and investments thereby introducing a role for inflation to drive household savings behavior.[8] Like before, there is a single household with CRRA preferences. We refer to this as the *benchmark* model. We find that the *path of inflation* plays a potential role in explaining the hump in the savings rate, though the levels of savings still do not match with the data. Intuitively, inflation has a direct bearing on the value of future wealth, i.e., a decline in inflation increases the real value of future wealth. Since households have perfect foresight, they foresee the changes in money supply and hence its effect on inflation. Anticipating low inflation in the late-2010s, they foresee low savings and high consumption in the future. To smooth consumption along the transition path, they increase consumption (or decrease savings) in the earlier part of the sample period, the early 1990s. This tendency is strengthened by risk aversion.

Thus, the savings rate rises in the 1990s, peaks around 2008 and, then along with falling inflation, the savings rate declines slowly over time. We show that the benchmark model weakly matches the non-monotonic trends in the savings rate, and does not match the peak savings

[8] While India adopted inflation-targeting in 2016, towards the end of our sample period, we abstain from analyzing the impact of any specific monetary policy regime in our paper.

rate in the data. The correlation for 1991-2008 between the calibrated savings rate from the benchmark model and the data is 0.56. For the latter period, i.e., 2009-2019, the correlation is 0.88. These correlations are statistically significant at the 1 percent level.

To address the problem of low peak savings, we allow for two types of households: Ricardian, who we broadly consider as "formal" workers, and who are "savers". Rule of Thumb households are considered as "informal" workers, who are "non-savers". We allow for risk aversion in both households, but a cash-in-advance constraint on both consumption and investment only for Ricardian households. With an increasing ratio of formal to informal workers, the model shows a better match with the rise in the savings rate. More formal workers - who save - relative to informal workers - who don't save - magnify the trends in savings. In other words, while inflation changes the real value of wealth, with high inflation in the pre-peak sample inducing a negative wealth effect, and low inflation in the post-peak sample inducing a positive wealth effect, perfect foresight induces households to want to smooth consumption inter-temporally. This suggests that demographic factors play a key role in driving savings rates in India, especially in the pre-peak period, i.e., 1991-2008. The model also captures the drop in the savings rate subsequent to 2008 with an improvement in the pre-peak and post-peak correlations in savings. The correlation in the pre-2008 period between model and data improves to 0.62 while that of the post-2008 period is 0.9. Both correlations are statistically significant at the 1 percent level level of significance. This suggests that our simple framework provides a good fit of the model to the data.

The rest of the paper is as follows. Section 2 briefly surveys the existing literature. We replicate Fernández et al. (2019) for the Indian economy in Section 3. Section 4 depicts the one-sector neoclassical growth model with risk-averse agents and money supply. We calibrate the benchmark model in Section 5. Section 6 extends the benchmark model with two agents. We run some policy recommendations in Section 7 to suggest what could increase the savings rate. Finally, Section 8 concludes.

2 Literature

There is a large literature which looks at the determinants of the savings rate – Fernández et al. (2019) for Latin American economies, Chen et al. (2009) for the USA, and Braun et al. (2009) and Chen et al. (2006) for Japan. By calibrating a standard neoclassical growth model, Fernández et al. (2019) and Chen et al. (2009) find that changes in TFP have played a crucial role in explaining the Latin American and American savings rates, respectively. Even in Japan, Chen et al. (2006) find that TFP growth rates are the primary drivers of the Japanese savings trajectory while Braun et al. (2009) find that changes in demographics had an additional role to play. Mody et al. (2012) look at the changes in the US savings rate between 2007 and 2009. Empirically, they find that the precautionary savings motive, to counter the increased uncertainty since the onset of the Great Recession, explains two-fifths of the rise in the US savings rate. For China, Wei and Zhang (2011) show that conventional mechanisms like life cycle factors, precautionary savings, financial development, habit formation or TFP growth are inadequate to explain the high levels of savings rate. They find that half of the 1990-2007 increase in the savings rate is driven by the need to save for their son's marriage prospects. In regions with a more skewed sex ratio, households with sons tend to save more in order to increase their son's chances of finding a bride in the marriage market.

Our paper contributes to the literature on the determinants of trends in the savings rate, especially in developing countries. To the best of our ability, we are the first paper to document and model the non-monotonic dynamics of savings rates in a major economy like India. Within the existing literature, Fernández et al. (2019) study the stationary savings trajectory of select Latin American countries and identify TFP growth as the key driver of long-run savings rate patterns during 1970-2010 for Chile, Colombia, and Mexico. The savings rates in these countries are stationary, in the sense that they appear to fluctuate around a constant level. Chen et al. (2009) discuss the declining savings rate in the US economy. They too find TFP growth to be the most important determinant of the savings rate.

Savings constitutes the base of non-inflationary capital formation, and capital formation constitutes a critical determinant of economic growth (see Rao (1980)). Given this, there is a large literature on the dynamic interaction between savings and inflation, and the implications for output growth.[9] Some of the questions that guide this research are: does inflation have a short-run effect or a long-run effect on savings and what are the dynamic interactions between the two? Is inflation detrimental to savings or does it induce agents to save more? What role does risk aversion have in the inflation-savings relation? The cross-country and India specific evidence is, however, inconclusive. An early paper by Campbell and Lovati (1979) in the context of the US found no definitive evidence whether inflation has a long-term positive effects on savings. Other studies have found a negative association between inflation and the savings rate, i.e., Lahiri (1989) in the case of some Asian countries, Dayal-Gulati and Thimann (1997) in the case of Latin American countries, and Dash and Kumar (2018) in the case of India. Empirically, Heer and Süssmuth (2009) shows the impact of inflation on savings is not robust and depends on the sample period.[10] Our rationale for these extensions is located in the uniqueness of the post-reform trend in the savings rate for India, and the need for new insights into its savings dynamics.

High inflation rates may also co-exist with high personal savings. Davidson and MacKinnon (1983) show that a positive relation may arise when measured income and savings, even when deflated by the price index, can overestimate real income and savings. An increase in inflation may coincide with higher savings because of uncertainty and pessimism regarding the future. In the case of India, Athukorala and Sen (2004) found that inflation positively affects the private saving rate over and above its effect operating through the real return to saving. This suggests that agents attempt to maintain a target real wealth relative to income by reducing consumption when faced with inflation. Samantaraya and Patra (2014), on the other hand, present an ARDL framework to understand the key determinants of household savings for the

[9]High inflation can have long-run adverse impacts on output growth through various channels. A key channel is exacerbating financial frictions and reducing the real returns on financial instruments, both of which dis-incentivize long-run capital formation (Choi et al. (1996)).

[10]For instance, Heer and Süssmuth (2009) shows that rising inflation was also associated with decreasing savings in the US during the Greenspan and pre-Volcker eras, but with increasing savings during the Volcker era.

period 1971 to 2012. They show that, among other variables, inflation and the real interest rate have negative effects on household savings, both in the short and long-run.

The evidence from the theoretical literature is also ambiguous. Sidrauski (1967) shows that in a general equilibrium framework, money is "super-neutral", and therefore, inflation does not affect savings in the long run. Stockman (1981) also shows from a model with a cash-in-advance or "CIA" constraint applied to consumption, an identical result is obtained, whereas when applied to investment, higher money growth results in lower savings. Dotsey and Sarte (2000) find that inflation affects long-run growth even when the CIA constraint only applies to consumption. These papers focus on a balanced growth analysis. Our focus is on the transitional dynamics of the savings path.

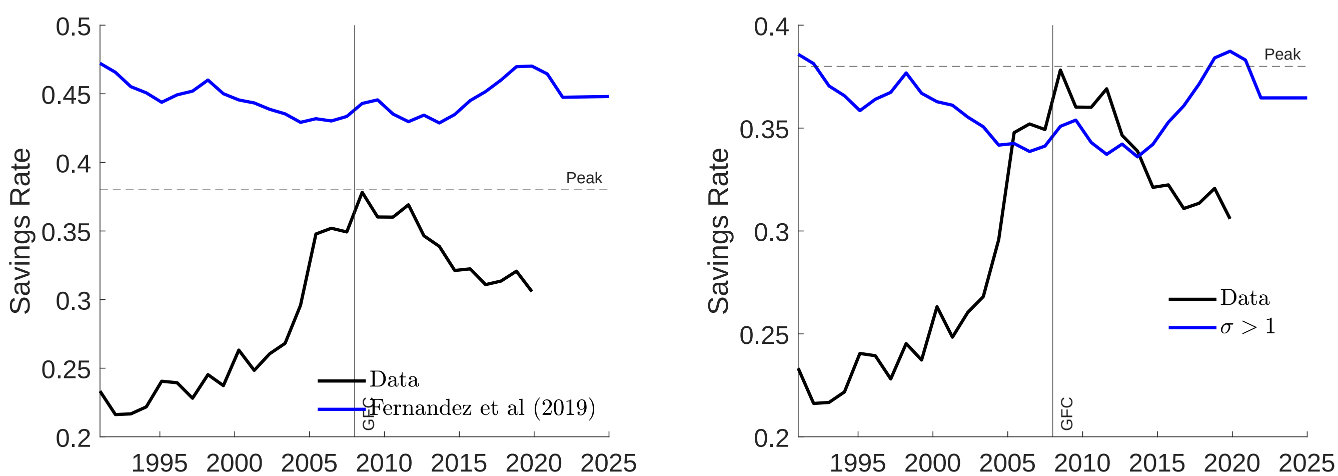
The inconclusive global empirical evidence on the relationship between inflation and savings, therefore, warrants a theoretical mechanism to understand the transitional dynamics of savings. As a first extension, we explore whether growth in monetary aggregates can help explain the trends in the savings rate in India. We show that by augmenting the one-sector neoclassical growth model in Fernández et al. (2019) with money and two types of households, we are able to recover the non-monotonic path of savings dynamics that some countries like India and China have experienced. Therefore, the key departure of our paper is that it contributes to understanding not just the contemporaneous effects of inflation on savings, but also the dynamic interactions using a neo-classical growth model with perfect foresight.

Given the large size of the informal sector in India (see Murthy (2019)), demographic changes also play a role in terms of changing the proportion of savers and non-severs. We follow Gabriel et al. (2012) and Bhattacharya and Patnaik (2016) in terms of modelling heterogeneous households. We find that the rising share of formal workers in the economy leads to general equilibrium interactions between the ratios of savers and non-savers and inflation which gives us a potential explanation of the non-monotonic savings rate.

3 Fernandez et al. Calibrated to Indian Data

Fernández et al. (2019) conducts a horse race on four exogenous variables to explain savings dynamics: the rate of growth of population, the growth rate of TFP, and two key fiscal policy variables such as the taxes on capital income, and the share of overall government expenditure in GDP. Their main result is that the dynamics of TFP growth drive savings dynamics in select Latin American economies compared to the other variables listed above.[11] In Figure 7 below, we calibrate the identical model in Fernández et al. (2019) to Indian data (the calibrated parameter values are explained in detail in Table 1). We plot two counterfactuals in Figure 7.

Figure 7: Calibrating Fernández et al. (2019) to Indian Data



(a) $\sigma = 1$ (b) $\sigma > 1$

In the left panel, we assume log-linear preferences ($\sigma = 1$). As the blue line shows, the calibrated savings rate declines throughout the sample period and does not replicate the hump-shaped savings pattern in the actual data (black line). In other words, the savings rate does not match the Indian data when $\sigma = 1$.

The right panel, (Figure 7b), plots Fernández et al. (2019) assuming CRRA preferences with $\sigma > 1$. This counterfactual (blue line) continues to be a poor fit of the actual data -

[11]While we do not outline Fernández et al. (2019) in our paper, our benchmark model without a cash-in-advance constraint and with $\sigma = 1$ is equivalent to their model.

the blue line overestimates the data by a large margin, with the peak savings rate happening around 2020. As can be seen in Figure 7, while the model including risk aversion yields some non-monotonicity in the savings rate from the model, it does not conform to the timing of the peak in the data. It is also not able to capture the steep rise in the savings rate during the pre-2008 period, and the subsequent decline.[12]

4 The Benchmark Model

As mentioned in the Introduction, the hump in the savings rate could possibly be driven by inflation dynamics interacting with risk-aversion over the sample period in the Indian economy. Further, as shown in Figure 6, we find that the M3 growth rate and inflation are strongly correlated with M3 growth *Granger causing* inflation over the sample period. We, therefore, construct a neoclassical monetary-growth model with perfect foresight. We refer to this as the *benchmark* model going forward. The model is standard. Money enters via a cash-in-advance constraint on both consumption and investment as in Dotsey and Sarte (2000). This allows us to capture the impact of inflation dynamics on household savings behavior in a tractable way. Introducing money via a cash in advance constraint allows us to generate a large deviation from neutrality that helps drive the *hump* in the Indian savings rate. The other features of the model are similar to Fernández et al. (2019).

On the production side, a representative firm produces a final good using capital, K_t and

[12] The basic mechanism driving savings in Fernández et al. (2019) is as follows. A capital-poor economy accumulates capital over time since the marginal product of capital is high. With an increase in capital accumulation, the rate of return on capital falls, which has two off-setting effects on current consumption. On the one hand, lower rates of return lower incomes, and hence due to the income effect, current consumption falls. In a static framework, both consumption and savings are bound to decline via the income effect. But given the inter-temporal nature of the household's optimization problem, the income effect channel results in a much more significant decline in consumption, which, on the net, results in an increase in savings. This enables consumption smoothing in future periods. The other effect of a fall in the rate of return, namely the substitution effect, however, disincentivises savings in the current period as the opportunity cost of current consumption is higher. The overall impact due to a fall in the rate of return determines which effect dominates. In Fernández et al. (2019), households have log preferences, i.e., a special case of CRRA preferences with the inter-temporal elasticity of substitution being equal to 1, where the income and substitution effects cancel out. For households with $\sigma > 1$, the income effect dominates over the substitution effect. This also supports the findings of Samantaraya and Patra (2014) who show using an ARDL framework that inflation and the real interest rate have negative effects on household savings, both in the short and long run. The adverse effects of high real interest rates on savings suggest that the income effect dominates the substitution effect.

labor, H_t using a Cobb-Douglas technology:

$$Y_t = K_t^{\theta}(A_t H_t)^{1-\theta}.$$

We assume that the labor augmenting TFP (A_t) grows exogenously. Solving a standard static profit maximization problem with respect to labor and capital yields

$$w_t = (1-\theta)\cdot\frac{p_t Y_t}{H_t}, \quad r_t = \theta\cdot\frac{Y_t}{K_t},$$

where p_t, w_t and r_t are the price of the final good, the nominal wage rates and the real return to capital, respectively.

A representative household with N_t working age members maximizes lifetime discounted utility:

$$\sum_{t=0}^{\infty}\beta^t N_t \frac{\left(c_t^{1-\alpha}(\bar{h}-h_t)^{\alpha}\right)^{1-\sigma}-1}{1-\sigma}, \quad \alpha\in(0,1);\ \sigma>0 \tag{1}$$

where, $c_t = {C_t}/{N_t}$ is per-capita consumption, $h_t = {H_t}/{N_t}$ is the per-capita labor and $\bar{h}$ is per-person time endowment. The parameters β, α and σ are the rate of discount, the share of leisure in the utility function and the rate of risk aversion, respectively. The household maximizes the discounted lifetime utility function subject to a cash-in-advance (2) and a budget constraint (3):

$$c_t N_t + \psi(K_{t+1}-(1-\delta)K_t) \le \frac{m_t}{p_t} + (g_{Mt}-1)\frac{M_t}{p_t}, \tag{2}$$

$$c_t N_t + K_{t+1} - (1-\delta)K_t + \frac{\kappa}{2}K_t\left(\frac{K_{t+1}}{K_t} - n_t g_{At}\right)^2 + \frac{m_{t+1}}{p_t}$$
$$\le (1-\tau_{Lt})\frac{w_t}{p_t}h_t N_t + \left(r_t - \tau_{Kt}\left(r_t-\delta\right)\right)K_t + \frac{m_t + (g_{Mt}-1)M_t}{p_t} + Z_t \tag{3}$$

Equation (2) states that consumption and a portion of investment, $\psi\in[0,1]$, requires cash-in-advance (CIA). This specification follows Dotsey and Sarte (2000). Real money balances are given by $\frac{m_t}{p_t}$, m_t is the household's nominal money balance, and M_t is the exogenous nominal stock of money in the economy. Equation (3) is the resource constraint faced by the household. The LHS describes household expenditure on consumption, investment (including capital adjustment costs) and future money holding. The RHS includes all income, including after-tax rental income from labor and capital, current money balances, money supply and transfers from the government (Z_t). $\delta \in [0,1]$ is the rate of depreciation of capital, while $\tau_{Lt} \in [0,1]$ and $\tau_{Kt} \in [0,1]$ are the exogenous taxes on labor income and capital income, respectively. g_{Mt}, n_t and g_{At} denote the growth rate of money, the growth rate of population, and the growth rate of TFP, respectively.

The first order conditions of the constrained optimization problem with respect to c_t, h_t, K_{t+1} and m_{t+1} respectively, yields:

$$(1-\alpha)\beta^t c_t^{-\alpha-\gamma(1-\alpha)}(\bar{h}-h_t)^{\alpha(1-\gamma)} = \lambda_{1t} + \lambda_{2t}, \tag{4}$$

$$\alpha\beta^t c_t^{(1-\alpha)(1-\gamma)}(\bar{h}-h_t)^{-\alpha\gamma-1+\alpha} = \lambda_{2t}(1-\tau_{Lt})\frac{w_t}{p_t}, \tag{5}$$

$$\lambda_{1t}\psi + \lambda_{2t} = \lambda_{1t+1}\psi(1-\delta) + \lambda_{2t+1}\left[1 + (1-\tau_{Kt+1})(r_{t+1}-\delta)\right], \tag{6}$$

$$\frac{\lambda_{1t+1}+\lambda_{2t+1}}{p_{t+1}} = \frac{\lambda_{2t}}{p_t}, \tag{7}$$

where λ_{1t} and λ_{2t} are the Lagrange multipliers for the CIA constraint and the household budget constraint, respectively.

The government budget constraint is as follows:

$$\tau_{Kt}\left(r_t-\delta\right)K_t + \tau_{Lt}\frac{w_t}{p_t}h_t N_t = \chi_t Y_t + Z_t \tag{8}$$

where $\chi_t = G_t/Y_t$ is an exogenous variable. The economy-wide resource constraint is:

$$c_t N_t + K_{t+1} - (1-\delta)K_t + \frac{\kappa}{2}K_t\left(\frac{K_{t+1}}{K_t}-1\right)^2 = (1-\chi_t)K_t^{\theta}(A_t H_t)^{1-\theta} \tag{9}$$

Equilibrium

As is standard in the literature, TFP and money supply grow at the exogenous rate g_{At} and g_{Mt}, i.e., $A_{t+1} = g_{At}A_t$ and $M_{t+1} = g_{Mt}M_t$. The equilibrium is determined such that the firm's and the household's optimization conditions are satisfied, and the government budget and the goods market clearing conditions hold. We make the system stationary by de-trending all variables – except labor and the returns to capital – to their normalized form. For any variable Z, its normalized form is $\tilde{z}$.

The stationary (de-trended) dynamic system is:

$$\text{CIA:} \quad \tilde{c}_t + \psi(g_{At}n_t\tilde{k}_{t+1} - (1-\delta)\tilde{k}_t) = \frac{g_{Mt}}{\tilde{p}_t},$$

$$\text{Mkt. Clg.:} \quad \tilde{c}_t + g_{At}n_t\tilde{k}_{t+1} - (1-\delta)\tilde{k}_t + \frac{\kappa n_t g_{At}}{2}\tilde{k}_t\left(\frac{\tilde{k}_{t+1}}{\tilde{k}_t} - 1\right)^2 = (1-\chi_t)\tilde{k}_t^{\theta}h_t^{1-\theta},$$

$$\text{FOC h:} \quad \tilde{\lambda}_{2t} = \frac{\alpha(\bar{h} - h_t)^{-\alpha\sigma-1+\alpha}\left(\tilde{c}_t\right)^{(1-\alpha)(1-\sigma)}}{(1-\tau_{Lt})\tilde{w}_t},$$

$$\text{FOC c:} \quad \tilde{\lambda}_{1t} + \tilde{\lambda}_{2t} = (1-\alpha)\left(\tilde{c}_t\right)^{(1-\alpha)(1-\sigma)-1}\left(\bar{h} - h_t\right)^{\alpha(1-\sigma)},$$

$$\text{FOC m:} \quad g_{\Lambda} \cdot \frac{\tilde{\lambda}_{1t+1} + \tilde{\lambda}_{2t+1}}{\tilde{\lambda}_{2t}} = \frac{g_{Mt}}{g_{At}n_t}\frac{\tilde{p}_{t+1}}{\tilde{p}_t},$$

$$\text{FOC k:} \quad \tilde{\lambda}_{1t}\psi - g_{\Lambda}\tilde{\lambda}_{1t+1}\psi(1-\delta) + \tilde{\lambda}_{2t}\left(1 + \kappa g_{At}n_t\left(\frac{\tilde{k}_{t+1}}{\tilde{k}_t} - 1\right)\right) =$$
$$g_{\Lambda}\tilde{\lambda}_{2t+1}\left[1 + (1-\tau_{Kt+1})(r_{t+1} - \delta) + \kappa\left(g_{At+1}n_{t+1}\right)^2\frac{\tilde{k}_{t+2}}{\tilde{k}_{t+1}}\left(\frac{\tilde{k}_{t+2}}{\tilde{k}_{t+1}} - 1\right)\right.$$
$$\left. - \frac{\kappa(g_{At+1}n_{t+1})^2}{2}\left(\frac{\tilde{k}_{t+2}}{\tilde{k}_{t+1}} - 1\right)^2\right]$$

$$\text{Firm FOCs:} \quad \tilde{w}_t = (1-\theta)\left(\frac{\tilde{k}_t}{h_t}\right)^{\theta}, \quad r_t = \theta\left(\frac{\tilde{k}_t}{h_t}\right)^{-(1-\theta)}$$

where $g_{\Lambda t} = \beta g_{At}^{(1-\alpha)(1-\sigma)-1}$ and the normalized variables are:

$$\tilde{k}_t = \frac{K_t}{A_t N_t}, \quad \tilde{c}_t = \frac{c_t}{A_t}, \quad \tilde{p}_t = \frac{p_t A_t N_t}{M_t}, \quad \tilde{w}_t = \frac{w_t}{p_t A_t},$$
$$\tilde{\lambda}_{1t} = \frac{\lambda_{1t}}{\beta^t A_t^{(1-\alpha)(1-\sigma)-1}}, \quad \tilde{\lambda}_{2t} = \frac{\lambda_{2t}}{\beta^t A_t^{(1-\alpha)(1-\sigma)-1}}.$$

Given the exogenous variables, $\{g_{At}, g_{Mt}, n_t, \chi_t, \tau_{Kt}, \tau_{Lt}\}_{t=0}^{\infty}$, we get the private savings rate equals to:

$$s_t = \frac{Y_t - G_t - c_t N_t}{Y_t} = \frac{k_{t+1} g_{At} n_t - (1-\delta) k_t}{y_t}$$

In the long run, $\lim_{t\to\infty}[g_{At}, g_{Mt}, n_t, \chi_t, \tau_{Kt}, \tau_{Lt}] = [g_A^*, g_M^*, n^*, \chi^*, \tau_K^*, \tau_L^*]$. We summarize the steady state in the Appendix. We have the following Proposition.

Proposition 1. *The steady-state savings rate is decreasing in the tax rate on capital income, money supply growth rate, and the growth rate of labor augmenting TFP. It is increasing in the population growth rate. Further, it is independent of government spending shares or the tax rate on labor income.*

Proof. From (A.5), (A.6) and (A.7), we get:

$$\frac{\tilde{\lambda}_1^*}{\tilde{\lambda}_2^*} = \ell = \frac{g_M^*}{g_A^* n^* g_\Lambda^*} - 1, \quad \frac{\tilde{y}^*}{\tilde{k}^*} = \frac{r^*}{\theta}, \quad 1 + (1-\tau_K^*)(r^* + \delta) = \frac{\psi\ell(1 - g_\Lambda^*(1-\delta)) + 1}{g_\Lambda^*}.$$

Based on the above expressions, we get the steady state savings rate is

$$\begin{aligned} s^* &= (g_A^* n^* - 1 + \delta)\frac{\tilde{k}^*}{\tilde{y}^*} \\ &= (g_A^* n^* - 1 + \delta)\theta \left[\frac{1}{(1-\tau_K^*)}\left[\frac{\psi\ell(1 - g_\Lambda^*(1-\delta)) + 1}{g_\Lambda^*} - 1\right] - \delta\right]^{-1} \\ &= s^*\left(\underset{-ve}{\tau_K^*}, \underset{-ve}{g_M^*}, \underset{-ve}{g_A^*}, \underset{+ve}{n^*}\right) \end{aligned}$$

□

Note, for $\sigma = 1$, we have $g_\Lambda^* = \beta/g_A^*$ and Proposition 1 continues to hold. This matches the findings in Barro and Sala-i Martin (2004).[13]

5 Calibration

We calibrate the benchmark model to match Indian data for the years 1991-2019. We choose the post-reform period as this period is a closer proxy to a market economy (see Ghate et al. (2013)). For our analysis, we focus on six major exogenous variables across different models. The variable χ_t is matched to the government spending share as a percentage of GDP. τ_{Lt} is equal to the ratio of total direct taxes to GDP whereas τ_{Kt} is the ratio of total corporate taxes to GDP, all of which are calculated using the RBI Handbook of Statistics. The growth rate of labor (n_t) is approximated by employment growth. This and labor-augmenting TFP growth (g_{At}) data, both, are obtained from the India KLEMS database (see RBI (2022)). These variables are common with Fernández et al. (2019). From the same data source, we get the growth rate of broad money (g_{Mt}), i.e., the M3 growth rate.[14]

Figure 8 plots the exogenous variables for India. We find that the government spending share has remained flat at around 11–12%. Labor taxes have risen over time, whereas, capital tax rates peaked around the same time as the savings rate, before declining. M3 growth has been declining after 2007. Trends in labor growth and labor augmenting TFP have, however, remained stable.

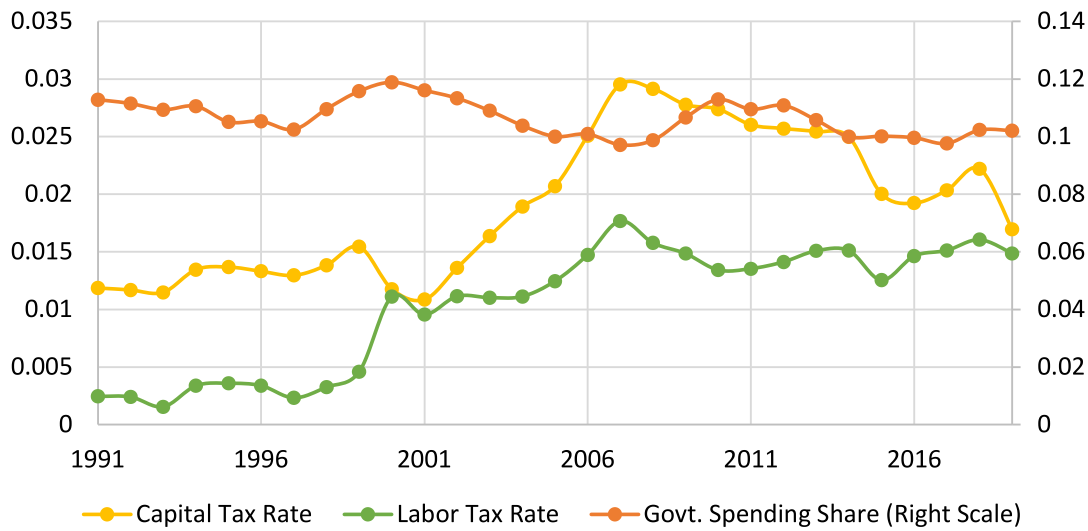
We list parameters in Table 1. The discount rate $\beta = 0.96$ is obtained by taking the average of the inverse of the real interest rate obtained from the WDI for the period 1991-2019. The capital share $\theta = 0.5$ is obtained from the India KLEMS database by taking the average share during the period 1991-2019. Finally, $\alpha = 0.15$ is calibrated to obtain the average labor hours for India from the CBTED database. The total labor hours, $\bar{h} = 2496$ is the legal requirement of the total labor endowment, based on an 8-hour working day for a six-day working week. The remaining four parameters, κ, δ, σ and ψ, are matched to existing values in the literature.

[13] In a continuous time Ramsey model with CRRA preferences, Cobb Douglas production, population growth and labor augmenting TFP growth, the steady-state savings rate depends positively on the population growth rate and negatively on TFP growth rate (see Chapter 2, Appendix 2C, Barro and Sala-i Martin (2004)).

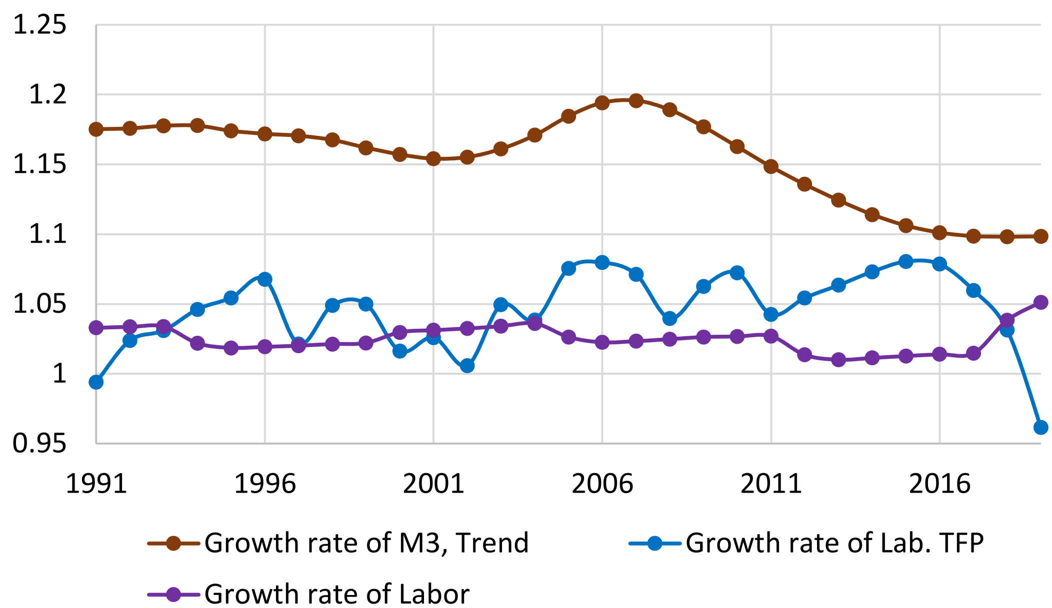
[14] Since the growth rate of M3 fluctuates a lot, we use the trend component of M3 growth in our model.

The steady-state values of all exogenous variables are assumed to be equal to the average values during the period 1991-2019. These are summarized as starred values in Table 1. The

Figure 8: Exogenous Trends in Potential Drivers of Savings.



(a) Fiscal Variables



(b) Growth Rate of M3, Labor, and Labor Productivity

Table 1: Parameters for the Benchmark Calibration

Parameter	Value	Description	Source
β	0.96	Discount factor	Authors' Calculations; WDI
θ	0.5	Capital share	India KLEMS, RBI (2022)
α	0.12	Weight on leisure	Calibrated
$\bar{h}$	2496	Total labor hours	Legal Requirement
δ	0.1	Capital deprec. rate	Feenstra et al. (2015)
σ	2	CRRA parameter	Gabriel et al. (2012)
κ	2	Cap. adj. cost parameter	Banerjee and Basu (2019)
ψ	1	Fraction of investment financed by cash	Cooley and Hansen (1989)
χ^*	0.10	Government spending as % GDP	GOI (2023)
τ_K^*	0.019	Capital tax rate	GOI (2023)
τ_L^*	0.0104	Labor income tax rate	GOI (2023)
g_M^*	1.1545	Money supply growth rate	RBI (2023)
n^*	1.0252	Employment growth	India KLEMS, RBI (2022)
g_A^*	1.0455	Lab Aug. TFP growth	India KLEMS, RBI (2022)

initial normalized capital is fixed such that

$$\frac{\tilde{k}_0}{\tilde{k}^*} = \frac{K_{t=1991}/\left(A_{t=1991} \cdot N_{t=1991}\right)}{K_{t=2019}/\left(A_{t=2019} \cdot N_{t=2019}\right)} = 0.885.$$

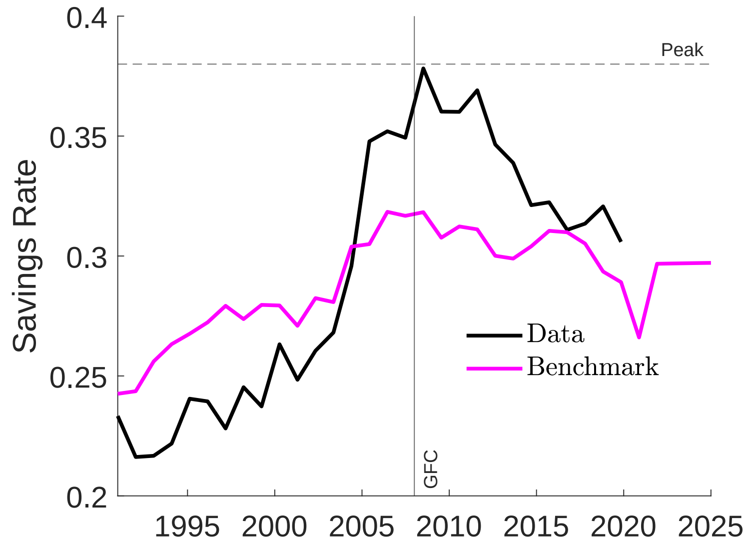
Based on Table 1, we calculate the steady-state values in the Appendix. Further, we match some of the long-run moments of the data and the model in Table A.3. The match between the benchmark model and data is quite close.

We plot the savings rate for the benchmark model and data in Figure 9.[15] With $\sigma > 1$, the income effect dominates and this explains the rise in the savings rate. However, the model also shows weak non-monotonicity in the savings rate around 2008. The peak savings rate in the model arises in 2006 at 33%, much lower than what is seen RBI data. The correlation for 1991-2008 between the benchmark model and data is 0.88, while in the latter period, it is 0.56. The correlations are statistically significant at the 10% level of significance. The only concern is that the mid-period savings rates are much lower and the hump is not as sharp in the model relative to the data.

The benchmark model has two mechanisms driving the savings rate: (a) risk aversion, and

[15] We use MATLAB 2022b version and Dynare 5.3 versions to calibrate the model.

Figure 9: Savings Rate: Benchmark vs. Data



(b) the role of inflation (via money supply). In the data, the pre-2008 period is characterized by a fall in the real rate of return on capital and high inflation. CPI inflation peaked in 2009, after which it fell steadily. Since the household can foresee the time paths of the real rate of return and inflation in our model, a high future wealth due to low future inflation and risk aversion will translate into front-loading of consumption by the household in the initial periods. Furthermore, to smooth the path of consumption in transition, the household increases its savings in the run-up to the peak of CPI inflation in 2009. Thereafter, during the phase of declining inflation, i.e., post-2009, the savings rate stagnates. We observe this in Figure 9.

6 Adding Heterogeneity

There is a large literature on how demographic changes play a key role in the rise of savings rates.[16] We now incorporate demographic changes into the benchmark model to explain both

[16]In the context of India, see Curtis et al. (2015) and Curtis et al. (2017). In particular, Curtis et al. (2017) provides a unified framework to explain the saving patterns of Japan, China and India over the period 1955 - 2010. The demographic shifts (which include declining fertility and mortality, and increased longevity) change the ratio of savers to non-savers and the household size which in turn affect the savings rate. For India, they find that a reduction in family size is an important factor that explains the trends in savings rates. Further, a forecast till 2050 shows that India's savings rate is likely to grow and remain high relative to its 2000 levels. While this quantitative life cycle model explains the long-run trends in savings rates up to 2010, it does not

the rise and the decline in the Indian savings rate in the post-liberalization era. We consider two types of representative households - "Ricardian" and "Rule of Thumb".[17] The Ricardian households are made up of formal workers and are savers. They continue to remain risk-averse households as in the benchmark model, Section 4. They consume, c_{Rt}, and save in the form of investment goods and hold money balances inter-temporally. They face a CIA constraint on consumption and investment.

The rule of thumb households are assumed to be made up of informal workers and do not save.[18] Their consumption is denoted by, c_{Pt}. They earn less than the formal workers and consume all their earnings from wage income. At every period, the ratio of formal to informal workers is denoted by x_t.

The informal worker maximizes the following lifetime utility function:

$$\sum_{t=0}^{\infty} \beta^t N_{Pt} \frac{\left(c_{Pt}^{1-\alpha}(\bar{h} - h_{Pt})^{\alpha}\right)^{1-\gamma} - 1}{1-\gamma}$$

subject to the budget constraint $w_{Pt}h_{Pt}N_{Pt} = p_t c_{Pt} N_{Pt}$. Note, $N_{Pt} = L_t/(1+x_t)$ is the size of the informal sector, while L_t is the total labor force in the economy. h_{Pt} is the per-capita labor hours supplied by the worker who earns w_{Pt} which goes into the consumption of the final good, c_{Pt}. The first-order conditions are:

$$h_{Pt} = (1-\alpha)\bar{h}, \quad p_t c_{Pt} = (1-\alpha) w_{Pt} \bar{h}. \tag{10}$$

address the short-term (hump-shaped) changes in the savings rate witnessed for India. Given that there have been no sudden changes in the age distribution of India's population or fertility rates, these factors are unlikely to explain the sudden decline in the Indian savings rate post-2008. As the 2008-decline in savings rate has been persistent, having heterogeneous (in our model, two types) agents seems like a natural next step to incorporate into the model.

[17] See Gabriel et al. (2012), Bhattacharya and Patnaik (2016), and Banerjee et al. (2020) for two-agent DSGE models in the Indian context

[18] Typically, in the literature, liquidity-constrained households, which form a sizable share of households in emerging and developing economies, undertake savings for pre-cautionary purposes. However, given that their incomes are stationary and stochastic, they save as often as they dissave. Therefore, in the net, they may not contribute sufficiently to aggregate savings behavior (see Deaton (1991)). In this paper, however, we do not assume stochastic incomes.

Firms produce final output using composite labor and capital. Composite labor aggregates both formal and informal labor. To allow for formal and informal labor to be substitutes or complements, we assume that the production function is a nested CES function similar to Ghate et al. (2016).

$$Y_t = K_t^{\theta} \left(A_t \left(a H_{Rt}^{\rho} + (1-a) H_{Pt}^{\rho} \right)^{\frac{1}{\rho}} \right)^{1-\theta}, \quad \rho < 1, \quad \theta \in (0,1)$$

where $1/(1-\rho)$ is the elasticity of substitution between the two types of labor, and $a \in [0,1]$ is the share of formal households in the production function. p_t is the price of the final good. The first-order conditions of the firm's problem are

$$r_t K_t = \theta Y_t, \quad w_{Rt} \frac{(a H_{Rt}^{\rho} + (1-a) H_{Pt}^{\rho})}{H_{Rt}^{\rho-1}} = a(1-\theta) p_t Y_t,$$
$$\frac{w_{Pt}}{w_{Rt}} = \frac{1-a}{a} \left(\frac{H_{Pt}}{H_{Rt}} \right)^{\rho-1}.$$

Finally, the goods market condition is given by

$$c_{Rt} N_{Rt} + c_{Pt} N_{Pt} + K_{t+1} - (1-\delta) K_t + \frac{\kappa}{2} K_t \left(\frac{K_{t+1}}{K_t} - 1 \right)^2 = (1-\chi_t) Y_t.$$

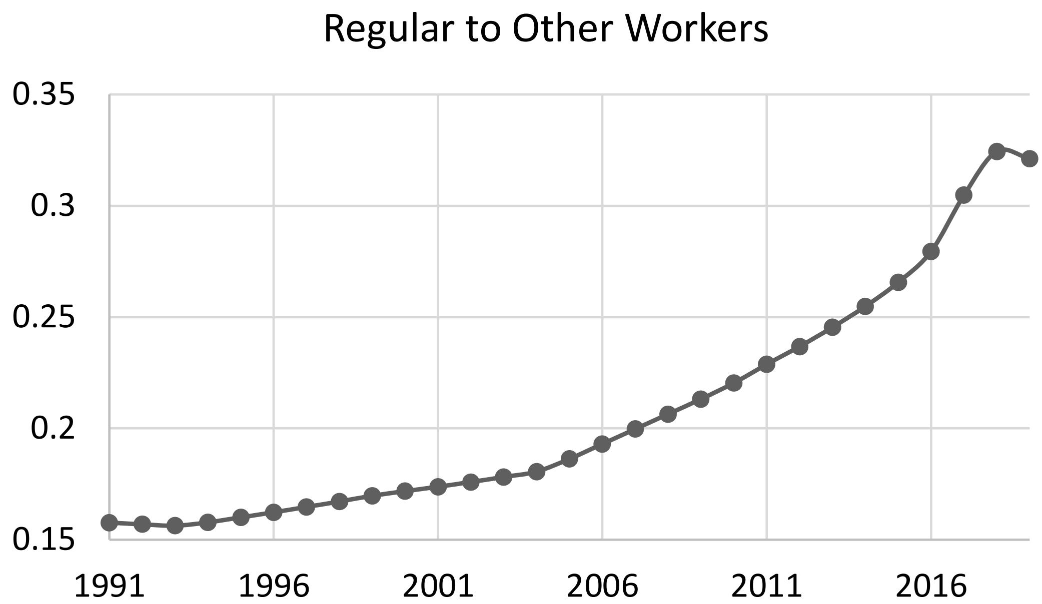
As in the benchmark economy, we derive the equilibrium conditions for the de-trended economy. We also make the system stationary by de-trending all variables – except formal and informal labor, and the returns to capital – to their normalized form. Therefore, as in the benchmark economy, for any variable Z, its normalized form is $\tilde{z}$.The stationary (or de-trended) dynamic system is:

$$
\begin{aligned}
\text{Prod Fun:}\quad & \tilde{y}_t = \tilde{k}_t^{\theta}\left(a\left(h_{Rt}x_t\right)^{\rho} + (1-a)h_{Pt}^{\rho}\right)^{\frac{1-\theta}{\rho}},\\
\text{F. Focs:}\quad & r_t\tilde{k}_t = \theta\tilde{y}_t, \quad \tilde{w}_{Pt}h_{Pt}\left(a\left(\frac{h_{Rt}x_t}{h_{Pt}}\right)^{\rho} + (1-a)\right) = (1-a)(1-\theta)\tilde{y}_t,\\
& \frac{\tilde{w}_{Pt}}{\tilde{w}_{Rt}} = \frac{1-a}{a}\left(\frac{h_{Pt}}{h_{Rt}x_t}\right)^{\rho-1},\\
\text{Poor Hh:}\quad & h_{Pt} = (1-\alpha)\bar{h}, \quad \tilde{c}_{Pt} = (1-\alpha)\tilde{w}_{Pt}\bar{h},\\
\text{CIA:}\quad & \tilde{c}_{Rt}x_t + \psi_t(g_{At}g_{NPt}\tilde{k}_{t+1} - (1-\delta)\tilde{k}_t) = \frac{g_{Mt}}{\tilde{p}_t},\\
\text{Mkt. Clg.:}\quad & \tilde{c}_{Rt}x_t + \tilde{c}_{Pt} + g_{At}g_{NPt}\tilde{k}_{t+1} - (1-\delta)\tilde{k}_t + \frac{\kappa\left(g_{NPt}g_{At}\right)^2}{2}\tilde{k}_t\left(\frac{\tilde{k}_{t+1}}{\tilde{k}_t} - 1\right)^2 = (1-\chi_t)\tilde{k}_t^{\theta}h_t^{1-\theta},\\
\text{FOC } h_R\text{:}\quad & \alpha\tilde{c}_{Rt}^{(1-\alpha)(1-\gamma)}(\bar{h} - h_{Rt})^{-\alpha\gamma-1+\alpha} = \tilde{\lambda}_{2t}(1-\tau_{Lt})\tilde{w}_{Rt}\\
\text{FOC } c_R\text{:}\quad & (1-\alpha)\tilde{c}_{Rt}^{(1-\alpha)(1-\gamma)-1}(\bar{h} - h_{Rt})^{\alpha(1-\gamma)} = \tilde{\lambda}_{1t} + \tilde{\lambda}_{2t}
\end{aligned}
$$

$$
\begin{aligned}
\text{FOC } m\text{:}\quad & \frac{g_{Mt}}{g_{At}g_{NPt}}\frac{\tilde{\lambda}_{2t}}{\tilde{p}_t} = g_{\Lambda}\frac{\tilde{\lambda}_{1t+1} + \tilde{\lambda}_{2t+1}}{\tilde{p}_{t+1}}\\
\text{FOC k:}\quad & \tilde{\lambda}_{1t}\psi - g_{\Lambda}\tilde{\lambda}_{1t+1}\psi(1-\delta) + \tilde{\lambda}_{2t}\left(1 + \kappa g_{At}g_{NPt}\left(\frac{\tilde{k}_{t+1}}{\tilde{k}_t} - 1\right)\right) =\\
& g_{\Lambda}\tilde{\lambda}_{2t+1}\left[1 + (1-\tau_{Kt+1})(r_{t+1} - \delta) + \kappa\left(g_{At+1}g_{NPt+1}\right)^2\frac{\tilde{k}_{t+2}}{\tilde{k}_{t+1}}\left(\frac{\tilde{k}_{t+2}}{\tilde{k}_{t+1}} - 1\right)\right.\\
& \left. - \frac{\kappa(g_{At+1}g_{NPt+1})^2}{2}\left(\frac{\tilde{k}_{t+2}}{\tilde{k}_{t+1}} - 1\right)^2\right]
\end{aligned}
$$

where $g_{NPt} = n_t(1+x_t)/(1+x_{t+1})$. Here, the detrending is done by dividing a variable by A_tN_{Pt}. We solve the steady state in the Appendix. Note, the savings rate expression is the same in the Benchmark and Proposition 1 holds as well. Thus, we find that the steady-state savings rate is independent of the new exogenous variable (x^*).

Figure 10: Ratio of Regular to Other Workers



Calibration

We use the data on regular workers as a proxy for the size of households that are Ricardian. The remaining workers, which include casual workers and self-employed workers, constitute Rule of Thumb workers. As seen in Figure 10, broadly the ratio of regular to other workers has been increasing since the 1990s.[19] Mehrotra (2019) finds that the number of casual wage workers (an important indicator of informal employment) increased between 2004-05 and 2011-12 (from 132.5 million to 141.9 million) before declining to 116 million in 2017-18. Hence a decline in the relative share of contractual workers in the sample period indicates that the size of the regular workers is increasing more rapidly than the the casual workers. The three additional parameters in this model are related to the labor composite and the steady state share of formal

[19]This data series is based on calculations using several rounds of the NSS and PLFS data. The Worker participation rates (WPR) based on usual principal and subsidiary status are obtained from the 50th (1993-94), 55th (1999-2000), 61st (2007-08), 66th (2009-10), and 68th (2011-12) NSSO rounds and three PLFS rounds (2017-18, 2018-19, 2019-20). The WPRs are then applied to the census population to derive the total number of persons employed for benchmark years. The data for the non-benchmark years are interpolated to create the time series for 1990-91 to 2019-20. The total number of people employed is further distributed to regular salaried and other workers. Other workers include casual and self-employed workers. Following NSSO and PLFS classifications, regular workers correspond to activity status code 31. Casual workers correspond to activity status codes 41 and 51. Finally, the self-employed workers correspond to activity status codes 11,12 and 21.

to informal workers. Their values are $\rho = -0.1$, $a = 0.6$ and $x^* = 0.3211$.[20] Further, we assume that the risk aversion of both types of households is the same, i.e. $\gamma = \sigma = 2$, as in Gabriel et al. (2012).

In Table 2, we show that the heterogeneous agent model shows a good fit with the data. The targeted moments, steady state annual working hours and labor share of output, match closely. We look at two un-targeted moments – the capital-output ratio and consumption-output ratio at the steady state. The capital-output ratio is close but less than its value in the Indian data. The fit in the consumption-output ratio is better.

Table 2: Fit of heterogeneous agent model with data

Variable	Targeted or Untargeted	Two Hh Model	Data
$[h_P^*, h_R^*]$	Targeted	[2048.3, 2196.5]	Annual avg working hrs is 2098
$\frac{w^*L^*}{p^*y^*}$	Targeted	0.5	Average labor share is 0.5
$\frac{k^*}{y^*}$	Untargeted	1.74	Average capital-output ratio is 3.09
$\frac{c^*}{y^*}$	Untargeted	0.60	Average consump-output ratio is 0.60

Figure 11 plots the savings rate of the model with heterogeneous agents. Compared to the benchmark economy, we find that including both types of agents is able to better track the dynamics of the savings rate. It also sharply captures the drop in the savings rate in the post-2008 period. The correlation in the pre-2008 period between model and data is 0.62 while that of the post-2008 period is 0.9. Both correlations are statistically significant at the 0.1% level of significance. The rising share of formal workers in the economy implies that the general equilibrium interactions between the ratio of savers to non-savers and inflation is able to provide a plausible explanation for the dynamics of the savings rate.[21]

[20]Unlike other exogenous variables, the ratio of regular to other workers shows a strong upward trajectory. Hence, the long-run value of x_t is assumed to be the last period value of the regular-to-other-workers ratio.

[21]The dynamics of savings are robust to a variety of separate extensions: a cash in advance constraint on poor household in addition to rich households; allowing for subsistence consumption for both poor and rich

Figure 11: The Role of Heterogeneity: Two-Household Economy

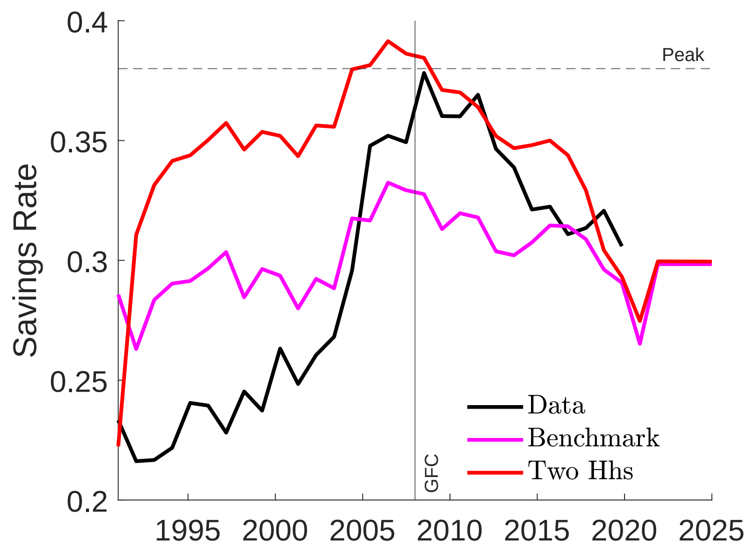
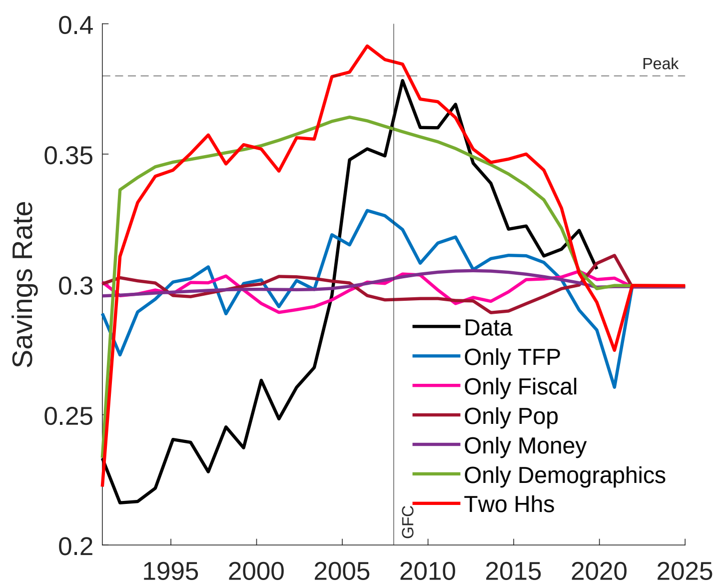


Figure 12: Decomposition: Two-Household Economy



How does adding two types of households change the mechanism? We decompose the savings rate pattern stemming from different exogenous variables. In Figure 12, the green line depicts the savings rate when only demographics (x_t) change as per data and all other exogenous variables are kept at their steady-state values. This is also the case for other lines. The pink

households; and habits in consumption for both households. In each case, we find that the results obtained from these extensions are qualitatively consistent with those obtained in Section 6. These results are available from the authors on request.

line shows the savings rate trajectory if only the fiscal variables $(\chi_t, \tau_{Kt}, \tau_{Lt})$ changed as per data while all other exogenous variables were constant. The hump in the savings rate is clearly driven by demographics, however, the short-term perturbations are explained by changes in the TFP growth rate. Inflation, demographics and the TFP growth rate – all three play a key role in understanding savings dynamics. As we saw before, the neo-classical growth model without money was inadequate in explaining the savings rate (as seen in Figure 7b). A monetary growth model with a TFP growth rate (and other exogenous variables) partially explains the hump-shaped savings rate pattern, but the hump is less pronounced and at a lower level (as seen in the Benchmark, Figure 9). To this model, when we add the growing proportion of savers to non-savers, the model matches the level in the Indian savings rate data quite well.

Post 2008, as inflation went down in India gradually, so did the need for household savings. Further, the role of greater formalization of the Indian economy pre-2008, which results in an increasing share of savers, magnifies the savings rate behavior and explains the pre-2008 rise in the savings rate. Due to declining inflation post-2008, Ricardian households reduce savings which, because of their rising demographic share, leads to a more pronounced decline in the savings rate. Thus, the ratio of the savers to non-savers magnifies the steeper rise and a sharper fall in the savings rate.

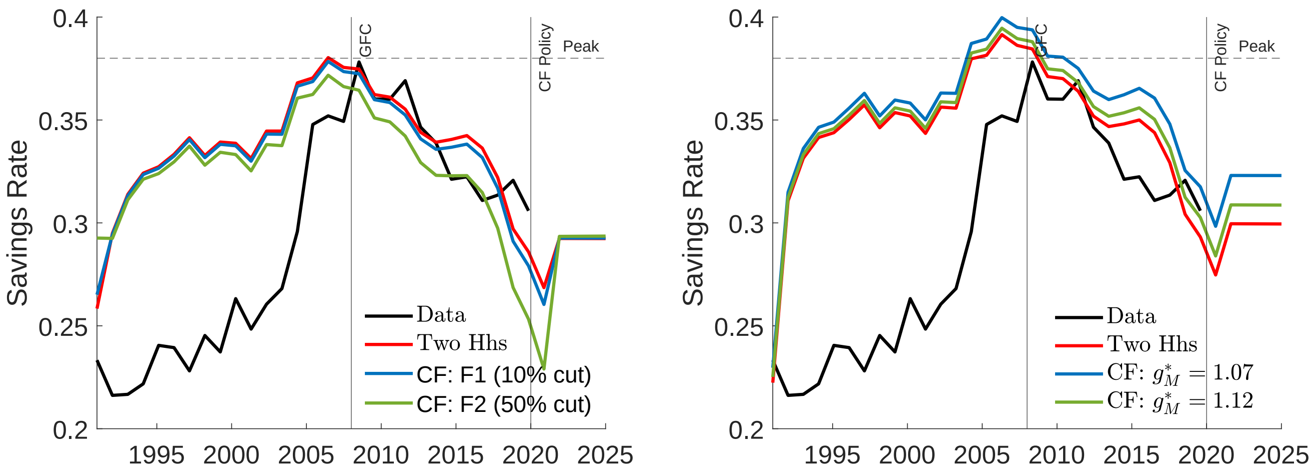
In sum, the dynamics of savings in this model is similar to that in the benchmark model, only the magnitude of effects has changed due to an increasing proportion of savers to non-savers. Relative to the benchmark economy, there are fewer savers but their proportion grows over time. As a result, we obtain lower savings rates for the initial periods compared to the benchmark model, but over time the model savings rate is closer to the data. We see this dynamic effect in Figure 11.

7 Policy Recommendations

Since we are able to match the dynamics of savings rates in India reasonably well, we ask: what policy changes could arrest the decline of the savings rate? We know from Proposition

1, lower capital taxes or growth rate of money supply would increase the steady-state savings rate. In Figure 13, we show the effects of these policy changes. When we cut the long-run average tax rates and share of government spending (averaged over our sample period) by 10 percent (Counter-factual CF $F1$) and then 50 percent (Counter-factual CF $F2$), we see that fiscal policy changes do not arrest the decline in the savings rate, imparting some scepticism to the notion that supply-side measures to boost the economy would increase savings. Monetary policy effects are more effective. From a baseline M3 growth of 15 percent, we reduce M3 growth to 7 percent (blue line) and 12 percent (green line). The savings rate increases by 1-2 percentage points, which is quite large.

Figure 13: Two Household Model Counterfactuals: With different long-run policies



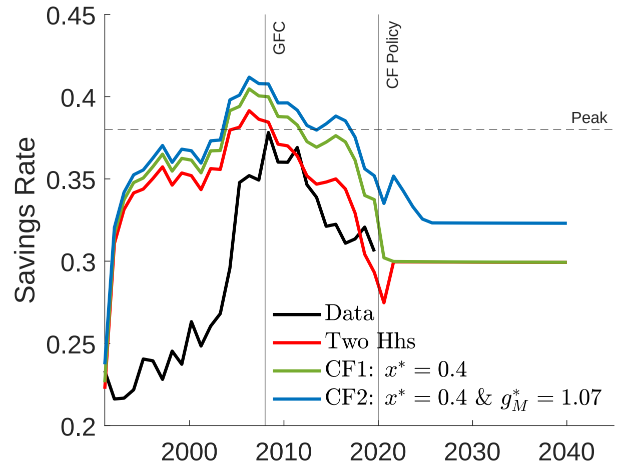
(a) Fiscal Policy

(b) Monetary Policy

In another policy experiment in Figure 14, we arbitrarily increase the steady-state share of formal to informal workers (x^* increases to 0.4 from 0.32). This increases the savings rate throughout the time period. This, along with a lower steady-state growth rate of money supply, has stronger short-term effects in increasing the savings rate, as can be seen in the blue line.

Even though the model is highly stylized, these experiments suggest that monetary policy changes that control inflation, interacting with a larger share of formal workers, have a bigger impact than fiscal policy in arresting the savings rate, but even then, the effects are weak in

Figure 14: Two Household Model Counterfactuals: Demographics interacts with long-run monetary policy



the two-household economy.

8 Conclusion

Household savings in India, while rising until 2008, declined consistently until 2019, and are low today. The standard neoclassical growth model does not explain the non-monotonic trajectory of the savings rates experienced by some large economies. Motivated by this, we build a stylized monetary-growth model to explain the dynamic interactions between savings and inflation to mimic the hump-shaped trajectory of the savings rate in the Indian economy since 1991. We show that the savings dynamics in India after 1991 can be explained by a model that incorporates inflation – introduced via a cash-in-advance constraint on consumption and investment – and the presence of informal and formal households. These variables jointly interact with exogenous fiscal policy variables and total factor productivity growth to affect savings dynamics. Introducing money via a cash in advance constraint allows us to generate a large deviation from neutrality that helps drive the *hump* in the Indian savings rate. Post 2008, as inflation went down in India gradually, so did the need for household savings as the real value of wealth rose. In the benchmark model, the decline in inflation interacts with TFP changes to explain a weak rise and then a fall in the savings rate. The rise in formal workers strengthens the non-monotonicity. Greater formalization of the Indian economy pre-2008, which results in an increasing share of savers, helps explain the sharp pre-2008 rise in the savings rate and the subsequent decline.

Our paper identifies a mechanism - that the path of inflation and savings are dynamically associated - and when coupled with risk aversion and household heterogeneity - these features mimic the hump-shaped pattern of savings seen in the Indian data. The framework offers a potential explanation of the Great Indian Savings Puzzle. Future work can empirically test the non-linear dynamic interaction of household savings and inflation in developing countries, as identified in our model. We have also not incorporated savings in physical assets in the model, whose fluctuations in value may have large wealth effects, and therefore impact household savings. We leave this for future work.

Acknowledgements

We are grateful for comments from Ravi Bansal, Ken Kletzer, participants of the "India's Economic Growth Conference: Past, Present, and Future" at ISI Delhi (April 2024), the 6th Asia KLEMS Conference (June 2023), the 9th Delhi Macroeconomics Workshop at IEG in March 2023, the February 2023 IEG-DEA-AKAM Workshop at IIM Calcutta, the IEG Brown Bag Seminar Series, Ashoka University, the Strategic Research Unit (RBI), the December 2022 ACEGD at ISI Delhi, the 2022 Indian Economic Association Meetings in Ranchi, Shiv Nadar University, and the International Conference on Applied Economics and Finance (ICAEF) at BITS-Pilani (December 2023). We thank Susmita Ray for her research assistance in earlier stages of this project.

References

Prema-Chandra Athukorala and Kunal Sen. The Determinants of Private Saving in India. *World Development*, 32(3):491–503, 2004.

Shesadri Banerjee and Parantap Basu. Technology Shocks and Business Cycles in India. *Macroeconomic Dynamics*, 23(5):1721–1756, 2019.

Shesadri Banerjee, Parantap Basu, and Chetan Ghate. A Monetary Business Cycle Model for India. *Economic Inquiry*, 58(3):1362–1386, 2020.

R Barro and Xavier Sala-i Martin. *Economic Growth (Second Edition)*. Cambridge MA.: The MIT Press, 2004.

Jaromir Benes, Kevin Clinton, Asish George, Pranav Gupta, Joice John, Ondra Kamenik, Mr Douglas Laxton, Pratik Mitra, GV Nadhanael, Rafael Portillo, Hou Wang, and Fan Zhang. *Quarterly Projection Model for India: Key Elements and Properties*. International Monetary Fund, 2017.

Rudrani Bhattacharya and Ila Patnaik. Financial Inclusion, Productivity Shocks, and Consumption Volatility in Emerging Economies. *The World Bank Economic Review*, 30(1):171–201, 2016.

R Anton Braun, Daisuke Ikeda, and Douglas H Joines. The Saving Rate in Japan: Why it has fallen and why it will remain low. *International Economic Review*, 50(1):291–321, 2009.

Claudia R Campbell and Jean M Lovati. Inflation and Personal Saving: An Update. *Federal Reserve Bank of St. Louis Review*, 61(Aug):3–9, 1979.

Kaiji Chen, Ayşe İmrohoroğlu, and Selahattin İmrohoroğlu. The Japanese Saving Rate. *American Economic Review*, 96(5):1850–1858, 2006.

Kaiji Chen, Ayşe İmrohoroğlu, and Selahattin İmrohoroğlu. A Quantitative Assessment of the Decline in the US Current Account. *Journal of Monetary Economics*, 56(8):1135–1147, 2009.

Sangmok Choi, Bruce D Smith, and John H Boyd. Inflation, Financial Markets, and Capital Formation. *Review-Federal Reserve Bank of Saint Louis*, 78:9–35, 1996.

Thomas F Cooley and Gary D Hansen. The Inflation Tax in a Real Business Cycle Model. *The American Economic Review*, 79(4):733–748, 1989.

Chadwick C Curtis, Steven Lugauer, and Nelson C Mark. Demographic patterns and household saving in china. *American Economic Journal: Macroeconomics*, 7(2):58–94, 2015.

Chadwick C Curtis, Steven Lugauer, and Nelson C Mark. Demographics and aggregate household saving in japan, china, and india. *Journal of Macroeconomics*, 51:175–191, 2017.

Santosh K Dash and Lakshmi Kumar. Does Inflation Affect Savings Non-Linearly? Evidence from India. *Margin: The Journal of Applied Economic Research*, 12(4):431–457, 2018.

Russell Davidson and James G MacKinnon. Inflation and the Savings Rate. *Applied Economics*, 15(6):731–743, 1983.

Anuradha Dayal-Gulati and Christian Thimann. *Saving in Southeast Asia and Latin America Compared: Searching for Policy Lessons*. International Monetary Fund, 1997.

Angus Deaton. Saving and Liquidity Constraints. *Econometrica*, 59(5):1221–1248, 1991.

Michael Dotsey and Pierre Daniel Sarte. Inflation Uncertainty and Growth in a Cash-in-advance Economy. *Journal of Monetary Economics*, 45(3):631–655, 2000.

Robert C. Feenstra, Robert Inklaar, and Marcel P. Timmer. The Next Generation of the Penn World Table. *American Economic Review*, 105(10):3150–3182, 2015.

Andrés Fernández, Ayşe İmrohoroğlu, and Cesar E Tamayo. Saving Rates in Latin America: A Neoclassical Perspective. *IMF Economic Review*, 67(4):791–823, 2019.

Vasco Gabriel, Paul Levine, Joseph Pearlman, and Bo Yang. An Estimated DSGE Model of the Indian Economy. In *Chetan Ghate (ed.), The Oxford Handbook of the Indian Economy*. Oxford University Press, 03 2012. ISBN 9780199734580. doi: 10.1093/oxfordhb/9780199734580.013.0029. URL https://doi.org/10.1093/oxfordhb/9780199734580.013.0029.

Chetan Ghate, Radhika Pandey, and Ila Patnaik. Has India Emerged? Business Cycle Stylized Facts from a Transitioning Economy. *Structural Change and Economic Dynamics*, 24:157–172, 2013.

Chetan Ghate, Gerhard Glomm, and Jialu Liu Streeter. Sectoral Infrastructure Investments in an Unbalanced Growing Economy: The Case of Potential Growth in India. *Asian Development Review*, 33(2):144–166, 2016.

GOI. National Accounts Statistics 2023. 2023. URL https://www.mospi.gov.in/publication/national-accounts-statistics-2023.

Burkhard Heer and Bernd Süssmuth. The Savings-Inflation Puzzle. *Applied Economics Letters*, 16(6):615–617, 2009.

Ashok K Lahiri. Dynamics of Asian Savings: The Role of Growth and Age Structure. *IMF Staff Papers*, 36(1):228–261, 1989.

Santosh Mehrotra. Informal Employment Trends in the Indian Economy: Persistent Informality, but Growing Positive Development. *ILO (working paper)*, 2019.

Ashoka Mody, Franziska Ohnsorge, and Damiano Sandri. Precautionary Savings in the Great Recession. *IMF Economic Review*, 60(1):114–138, 2012.

SV Ramana Murthy. Measuring Informal Economy in India–Indian Experience. In *Seventh IMF Statistical Forum, Washington, DC*, 2019.

Kakkadan N Raj. The Marginal Rate of Saving in the Indian Economy. *Oxford Economic Papers*, 14(1):36–50, 1962.

VKRV Rao. Savings, Capital Formation and National Income. *Economic and Political Weekly*, 79(4):965–977, 1980.

RBI. Measuring Productivity at the Industry Level - The India KLEMS Database. 2022.

RBI. Handbook of Statistics on Indian Economy. 2023. URL https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy.

Amaresh Samantaraya and Suresh Kumar Patra. Determinants of Household Savings in India: An Empirical Analysis using ARDL Approach. *Economics Research International*, 2014, 2014.

Miguel Sidrauski. Rational Choice and Patterns of Growth in a Monetary Economy. *The American Economic Review*, 57(2):534–544, 1967.

Alan C Stockman. Anticipated Inflation and the Capital Stock in a Cash in-advance Economy. *Journal of Monetary Economics*, 8(3):387–393, 1981.

Shang-Jin Wei and Xiaobo Zhang. The Competitive Saving Motive: Evidence from Rising Sex Ratios and Savings Rates in China. *Journal of Political Economy*, 119(3):511–564, 2011.

Appendix

Benchmark Model

Table A.1: Steady State System of Equations: Benchmark

Name	Equation	
CIA:	$\tilde{c} + \psi\tilde{k}(g_A n - (1-\delta)) = \frac{g_M}{\tilde{p}}$	(A.1)
Mkt. Clg.:	$\tilde{c} + g_A n\tilde{k} - (1-\delta)\tilde{k} = (1-\chi)\tilde{k}^{\theta}h^{1-\theta}$	(A.2)
FOC h:	$\tilde{\lambda}_2 = \frac{\alpha(\bar{h}-h)^{-\alpha\sigma-1+\alpha}\,(\tilde{c})^{(1-\alpha)(1-\sigma)}}{(1-\tau_L)\tilde{w}}$	(A.3)
FOC c:	$\tilde{\lambda}_1 + \tilde{\lambda}_2 = (1-\alpha)\,(\tilde{c})^{(1-\alpha)(1-\sigma)-1}\,(\bar{h}-h)^{\alpha(1-\sigma)}$	(A.4)
FOC m:	$g_\Lambda \cdot \frac{\tilde{\lambda}_1 + \tilde{\lambda}_2}{\tilde{\lambda}_2} = \frac{g_M}{g_A n}$	(A.5)
FOC k:	$\tilde{\lambda}_1\psi - g_\Lambda\tilde{\lambda}_1\psi(1-\delta) + \tilde{\lambda}_{2t} = g_\Lambda\tilde{\lambda}_2\left[1 + (1-\tau_K)(r-\delta)\right]$	(A.6)
Firm FOCs:	$\tilde{w} = (1-\theta)\left(\frac{\tilde{k}}{h}\right)^{\theta}, \quad r = \theta\left(\frac{\tilde{k}}{h}\right)^{-(1-\theta)}$	(A.7)

The steady-state values based on the Indian economy for the Benchmark are listed in Table A.2.

Table A.2: Steady State Values: Benchmark

$\tilde{k}^*$	6269.55	h^*	2079.72
$\tilde{c}^*$	2148.97	r^*	0.288
$\tilde{w}^*$	0.87	$\tilde{p}^*$	0.0003
s^*	29.84%	π^*	1.07711

In Table A.3, we show that the Benchmark model shows a good fit with data in other variables. The targetted moments, steady state annual working hours and labor share of output, match closely. We look at two untargeted moments – capital-output ratio and consumption-output ratio. The capital-output ratio is close to 2, both in the model and data. The fit in the consumption-output ratio is better.

Table A.3: Fit of benchmark model with data

Variable	Targeted or Untargeted	Fernández et al. (2019) with $\sigma > 1$	Benchmark	Data
h^*	Targeted	2179	2080	Annual avg working hrs is 2098
$\frac{w^* L^*}{p^* y^*}$	Targeted	0.5	0.5	Average labor share is 0.5
$\frac{k^*}{y^*}$	Untargeted	2.12	1.74	Average capital-output ratio is 3.09
$\frac{c^*}{y^*}$	Untargeted	0.53	0.60	Average consump-output ratio is 0.60

Heterogenous Agent Model

Table A.4: Steady State System of Equations: Two Household Economy

Name	Equation	
Prod Fun:	$\tilde{y} = \tilde{k}^{\theta} \left(a \left(h_R x\right)^{\rho} + (1-a) h_P^{\rho}\right)^{\frac{1-\theta}{\rho}}$	(A.8)
F. Focs:	$r\tilde{k} = \theta \tilde{y}, \quad \tilde{w}_P h_P \left(a \left(\frac{h_R x}{h_P} \right)^{\rho} + (1-a) \right) = (1-a)(1-\theta)\tilde{y}$	(A.9)
	$\frac{\tilde{w}_P}{\tilde{w}_R} = \frac{1-a}{a} \left(\frac{h_P}{h_R x} \right)^{\rho-1}$	(A.10)
Poor Hh:	$h_P = (1-\alpha)\bar{h}, \quad \tilde{c}_P = (1-\alpha)\tilde{w}_P \bar{h}$	(A.11)
CIA:	$\tilde{c}_R x + \psi(g_A g_{NP} \tilde{k} - (1-\delta)\tilde{k}) = \frac{g_M}{\tilde{p}}$	(A.12)
Mkt. Clg.:	$\tilde{c}x + g_A n \tilde{k} - (1-\delta)\tilde{k} = (1-\chi)\tilde{k}^{\theta} h^{1-\theta}$	(A.13)
FOC h_R:	$\alpha \tilde{c}_R^{(1-\alpha)(1-\gamma)} (\bar{h} - h_R)^{-\alpha\gamma - 1 + \alpha} = \tilde{\lambda}_2 (1-\tau_L) \tilde{w}_R$	(A.14)
FOC c_R:	$(1-\alpha)\tilde{c}_R^{(1-\alpha)(1-\gamma)-1} (\bar{h} - h_R)^{\alpha(1-\gamma)} = \tilde{\lambda}_1 + \tilde{\lambda}_2 (1+\tau_c)$	(A.15)
FOC m:	$\frac{g_M}{g_A g_{NP}} \frac{\tilde{\lambda}_2}{\tilde{p}} = g_{\Lambda} \frac{\tilde{\lambda} + \tilde{\lambda}_2}{\tilde{p}}$	(A.16)
FOC k:	$\tilde{\lambda}_1 \psi - g_{\Lambda} \tilde{\lambda}_1 \psi (1-\delta) + \tilde{\lambda}_2 = g_{\Lambda} \tilde{\lambda}_2 \left[1 + (1-\tau_K)(r-\delta)\right]$	(A.17)

The steady-state values based on the Indian economy for the two-household economy are listed in Table A.5.

Table A.5: Steady State Values: Heterogeneous Households

$\tilde{k}^*$	3172.75	h^*	1047.12
r^*	0.287	$\tilde{p}^*$	0.0009
h_P^*	2196.48	h_R^*	2048.3
$\tilde{c}_P^*$	338.512	$\tilde{c}_R^*$	2319.69
$\tilde{w}_P^*$	0.15	$\tilde{w}_R^*$	0.87
s^*	29.91%	π^*	1.07711

We also construct capital, K_t by applying the perpetual inventory method to the annual Gross Fixed Capital Formation obtained from the RBI Handbook of Statistics and assuming an annual depreciation rate to be 10% (see Feenstra et al. (2015)). Consumption data is obtained directly from the RBI Handbook of Statistics. The total annual working hours were obtained from the Conference Board Total Economy Database (CBTED).